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THE Festivus

Vol. 50(1)

February 2018



New volute from Mozambique

South African abalone

Cones from Brazil, Indonesia, and the Marquesas

Cowries from Greater New Zealand

Quarterly Publication of the San Diego Shell Club



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: 50

February 2018

ISSUE 1

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FRONT COVER:

Some volutes in the *Simililyria aiken* complex from South Africa and Mozambique courtesy of Roy Aiken and José Rosado. (Cover digital artistic credit: Rex Stilwill).

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The San Diego Shell Club was founded in 1961 as a non-profit organization for educational and scientific purposes. More particularly to enjoy, study and promote the conservation of Mollusca and associated marine life through lectures, club meetings and field trips. Our membership is diverse and includes beginning collectors, scientists, divers, underwater photographers and dealers.

THE FESTIVUS is the official quarterly publication of the San Diego Shell Club, Inc. and is issued as part of membership dues in February, May, August and November. *The Festivus* publishes articles that are peer reviewed by our volunteer Scientific Peer Review Board, as well as articles of general interest to malacologists, conchologists, and shell collectors of every level. Members of the Peer Review Board are selected to review individual articles based upon their chosen field of expertise and preference. Available by request or on our website are:

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West Coast Shell Show: August 25-26, 2018
COA 2018 in San Diego: 8/29 - 9/2/2018
November Shell Auction: 11/17/2018 from 1:00 p.m.
Holiday Party: 12/8/2018 from 1:00 p.m.

Publication date: February 1, 2018
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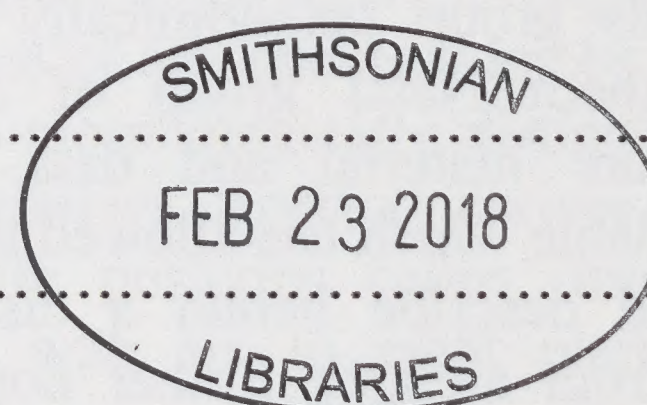
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Editor's Note: *The Festivus* is accepting articles for future issues. Articles of a scientific nature may be submitted for the peer reviewed portion of our journal. Please refer to our Guidelines for Authors, and/or Guidelines for the Description of New Taxa in *The Festivus*, both available on our website: <http://www.sandiegoshellclub.com/festivus/>. Articles are subject to a blind peer review process, and submission of an article does not guarantee acceptance or publication. We also accept articles of general interest to malacologists, conchologists and shell collectors for publication in the general interest section of our journal. All articles must be accompanied by either the author's original artwork, or a signed copyright waiver from the copyright holder.

Revision of the *Simililyria aikeni* Complex, with the Description of a New Subspecies

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ABSTRACT A new subspecies in the *Simililyria aikeni* complex from Mozambique is described, and a re-assessment of the distribution data for the group is provided.

KEY WORDS *Simililyria*, *Simililyria aikeni*, *Simililyria aikeni bazarutensis*, Mozambique.

INTRODUCTION

In Strandloper 276 (2004-2005), Aiken and Marais started initial work on the “*Simililyria queketti*” group in their article “The tribe Lyriini from the East Coast of Africa.” Then, in the Volute section of the Identification Guide to Seashells of South Africa (Marais and Seccombe, 2010), *Lyria queketti* was presented as five forms, labeled therein as A to E. In Malacologia 75, Vellies Veldsman (2012) separated this group taxonomically from the distant Southern Natal group of *Simililyria queketti*. More material and data has now become available which has allowed the authors to study and describe herein a distinct new subspecies from an area further north of the known distribution area. Additionally, with more specimens being made available, it is now possible to present two other specific, localized variants of the group that were never properly illustrated. Images of specimens representing these variants are presented in an accurate sequence from South to North Mozambique. Veldsman, in Malacologia 75, alluded to the fact that information from trawlers is not very accurate at all, and their original paper utilized all data that was available at that time. However,

a new and more accurate distribution map of the complex can now be presented (see Figure 1).

Detailed distribution of the *Simililyria aikeni* complex (from bottom of chart, upwards):

- *S. aikeni kosibayensis* - from Kosi Bay to Bilene area, in 90 to 180 metres, including pale variant with very light background. Also crabbed in lobster traps and nets, at 200 to 270 metres. Size 45 to 70 mm. (Blue and Green)
- *S. aikeni aiken* - from Boa Paz to Quissico in 115 to 130 metres. Live taken by Russian trawlers during the 1990's. Unfortunately, still no record of animal colour/pattern. Size 50 to 70 mm. (Red)
- *S. aikeni inhacaensis* - from Zavora to Massinga, crabbed in traps at 120 to 140 metres. Also from lobster trawlers at 200 to 270 metres. Size 40 to 70 mm. (Brown)
- *S. aikeni inhacaensis* - striped variant, from Massinga to Cabo Sao Sebastiao, crabbed in traps at 120 to 140 metres. From lobster trawlers, crabbed at 200 to 270 metres. Size 40 to 60 mm. (Orange)
- *S. aikeni bazarutensis* ssp.nov - From North Bazaruto Island to South Sofala Bank, trawled crabbed 220 to 275 metres. Size 30 to 45 mm. (Pink)



Figure 1. Distribution map of the *Simililyria aikenii* group. Map adapted from Pbsouthwood, 2007, Wikipedia Creative Commons.

General habitat of the group: In fine muddy sand, on or around flat rocks in the region of sponges and gorgonian reefs.

SYSTEMATICS

Class Gastropoda

Infraorder Neogastropoda

Superfamily Muricoidea

Family Volutidae

Genus *Simililyria* Bail & Poppe, 2001

Simililyria aikenii bazarutensis ssp. nov.

Aiken and Rosado, 2018

Description. Average size is the smallest in the *Simililyria aikenii* group, at 38 mm. Shell ovate fusiform with solid, distinctly squat appearance. Surface noticeably dull, with matt appearance. Protoconch and teleoconch whorls very pale uniform grey. Spire low, early whorls with distinct sutural channel. Strong multiple radial grooves/striae cover the entire whorl. Blunt, low

and strong axial ribbing covering the entire whorl from suture to base, with a smooth shoulder. These fairly broad ribs create a coronate effect at the suture throughout the shell. The absence of any shoulder knobs renders this subspecies morphologically distinctive from its southern relatives. Aperture narrow, white, with flared white posterior callus, interior white. Columella with six to eight plaits, regularly spaced, strongest anteriorly. Two separate, small but distinct plaits exist towards the posterior end of the columella, creating a notch in some specimens. Base colour pale grey, with continuous radial red to orange-red lines covering the whorl, and two vague deeper red bands, in an upper and lower zone of the whorl (see Figure 2).

Distribution. Taken from 120 to 270 metres depth off Bazaruto Island from trawling activity in earlier years. Also taken off Bartolomeu Dias and Northern Bazaruto Island, by trawlers at

220 to 275 metres. Holotype obtained as an attachment to a specimen of *Xenophora pallidula*.

Types.

Holotype - Height 33.6 mm x Width 16.0 mm, Aperture 22.6 mm. Catalogue and Type number, M 0213/ T 4278. Housed in the Natal Museum, Pietermaritzburg, Natal, South Africa.

Paratype 1: Height 43.6 mm x Width 21.8 mm. In collection J. Rosado.

Paratype 2: Height 43.1 mm x Width 20.5 mm. In collection R. Aiken.

Paratype 3: Height 31.7 mm x Width 16.6 mm. In collection J. Rosado.

Paratype 4: Height 33.9 mm x Width 16.2 mm. In collection J. Rosado.

Etymology. The name *bazarutensis* derives from the Island marker, off which this deep water subspecies has been obtained.

DISCUSSION

Albeit that this discovery is noticeably different, the authors are of the opinion that it still falls within the parameters of the same 'aikenii' group, particularly based on proximate locality, as this 'tribe' spread and localized over millennia.

We re-iterate, that this 'pattern' of a locally spread but differentiated group, is also to be found off Eastern Australia (the *Pulchra* complex), and Southern Japan (*Fulgoraria*, per Bail, 2000).

This very rare subspecies has been known for some time, but from extremely few specimens and can be distinguished from all other members of the group by its ovate morphology, deep radial grooves on the whorl, lack of

shoulder knobs and very far northern distribution (see Figure 3). At least two of the types show distinct signs of drilling into earlier whorls by an unknown predator, possibly a muricid. These drill holes are a regular feature of many *kosibayensis*, and *queketti parkrynieensis* specimens.

Two consistently different variants in the group have also been brought to light, namely:

- A very attractive variant of *kosibayensis* from Techobanine area, with distinctive **very pale** background. Fresh specimens even exhibit this noticeably light background.
- An *inhacaensis* variant with uniform red radial lines only, showing no banding on the whorl.

ACKNOWLEDGEMENTS

The authors are indebted to Alan Seccombe for his initial advisement as to the existence of this distinct, rare subspecies. Thanks also to the peer reviewer and the editor David P. Berschauer for guidance on the text.

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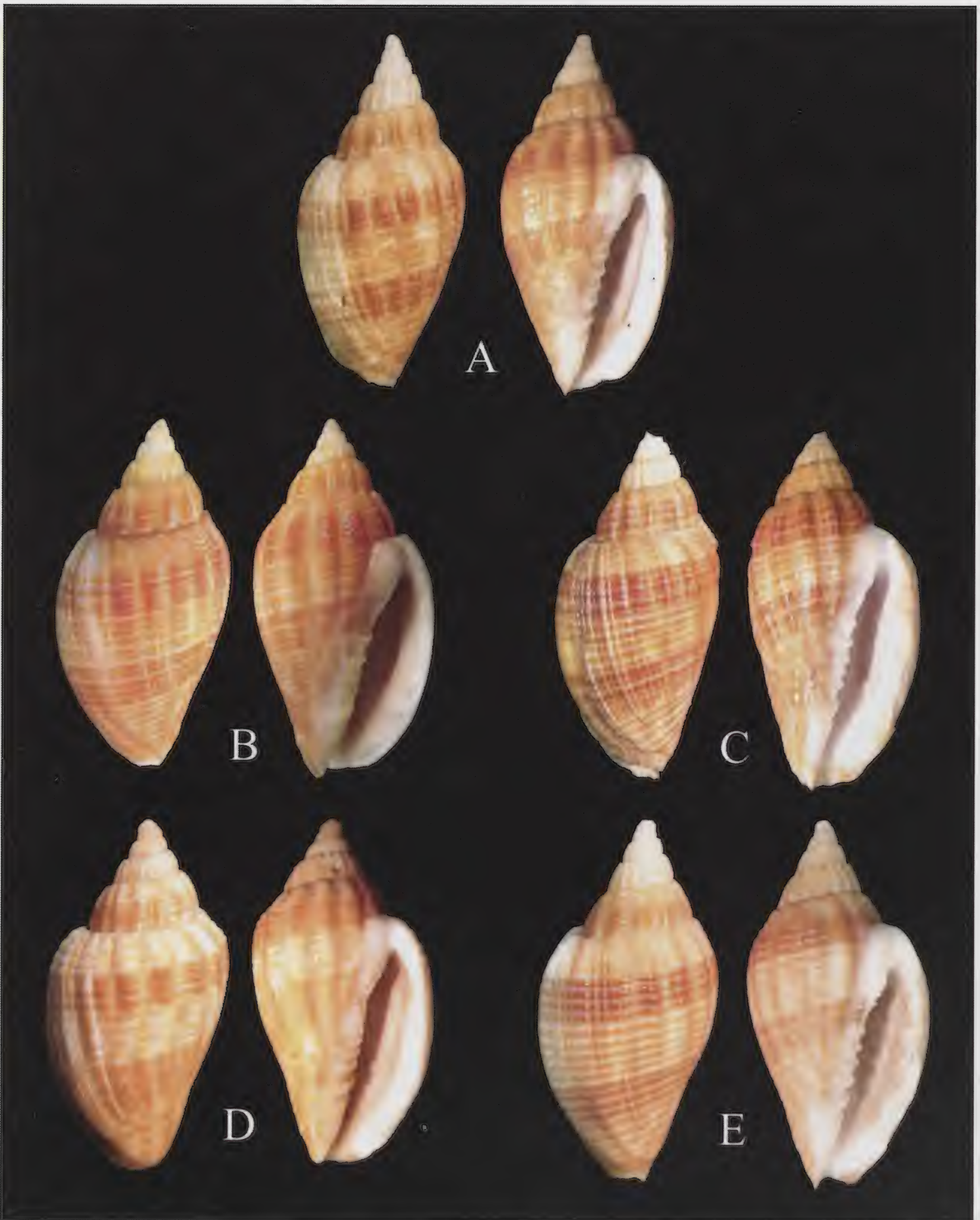


Figure 2. *Simililyria aikenii bazarutensis* ssp. nov. A = Holotype - 33.6 mm; B = Paratype 1 - 43.6 mm; C = Paratype 2 - 43.1 mm; D = Paratype 3 - 1.7 mm; E = Paratype 4 - 33.9 mm.

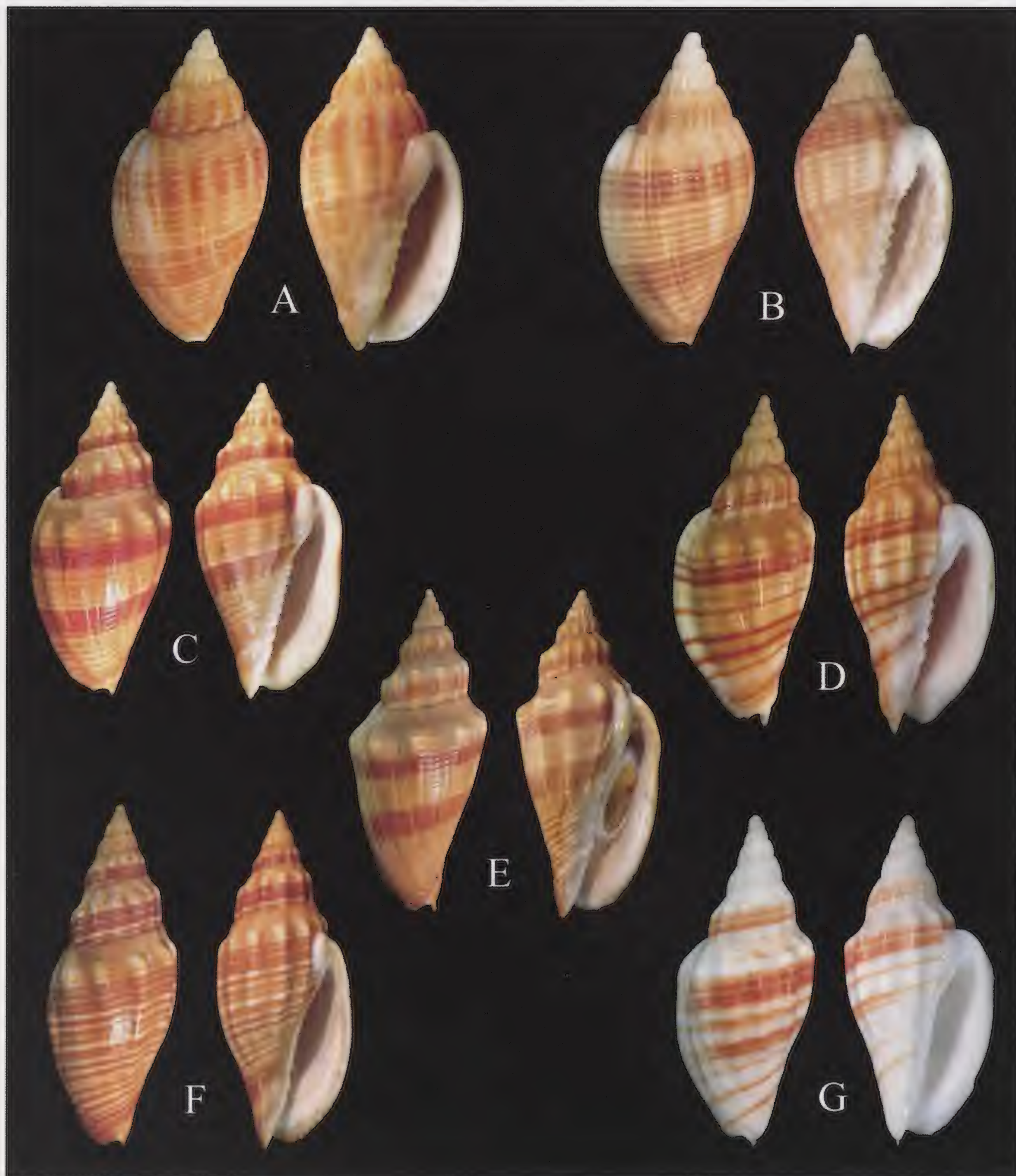


Figure 3. Comparison of the *Simililyria aikenii* complex.

A = Paratype 1 *Simililyria aikenii bazarutensis* ssp. nov., from off Sofala Bank; **B** = Paratype 4 *Simililyria aikenii bazarutensis* ssp. nov., from North Bazaruto; **C** = Typical form of *Simililyria aikenii inhacaensis*, from off Zavora; **D** = Typical form of *Simililyria aikenii kosibayensis*, from deep water off Techobanine area, south of Inhaca; **E** = Classic form of *Simililyria aikenii aikenii*, from Quissico Bank; **F** = *Simililyria aikenii inhacaensis*, uniform striped variant, from Massinga; **G** = *Simililyria aikenii kosibayensis*, rare smaller very pale variant, from off Kosi Bay.

Iconography of Haliotidae of Southern Africa

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ABSTRACT The five living species of Haliotidae found in Southern African waters are discussed in detail, descriptions are provided, and a series of images illustrate the variability in color and pattern of these species and a differential diagnosis photographic plate is provided.

KEYWORDS Haliotidae, South Africa.

INTRODUCTION

The combined ranges of the five South African *Haliotis* species extend from approximately the False Bay coast near Cape Town, to northern Natal (Figure 6). Two of the five abalone species (*Haliotis midae* Gmelin, 1791, and *H. spadicea* Donovan, 1808) are very common, the first having been commercially fished for many years; a third species (*H. parva* Linnaeus, 1758) is much less common and is quite popular with *Haliotis* shell collectors due to its bright and colorful shell patterns; while the remaining two taxa (*H. queketti* Smith, 1910, and *H. alfredensis* Bartsch, 1915) are quite small (the first <50 mm, the second <80 mm), are uncommon to rare, and are highly sought by shell collectors. These five South African abalone species are individually discussed below.

Abbreviation of Collections: **MJC:** Mark Jones Collection, New Zealand. **DDC:** Dwayne Dinucci Collection, Auburn, California, USA. **RKC:** Robert Kershaw Collection, Narooma, NSW, Australia. (All other shells in Buzz Owen Collection).

SPECIES ACCOUNTS

Haliotis midae Linnaeus, 1758. (Figure 1)

One of the world's six to seven largest abalone species attaining a size in excess of 230 mm, though not common over 200 mm primarily due to extreme fishing pressure and a severe poaching problem.

Description. Shell large (to 234 mm MJC), somewhat elongate, slightly arched, hardly convex, medium weight to heavy. Spire low, visible in ventral view. Holes small, round, strongly raised, usually 7-10 open. Dorsal surface with tightly spaced, narrow, sharp, radial lamellae. Lamellae may be discontinuous between suture and row of holes (lamellae are often not present on juveniles <30 mm). Columella in anterior part of medium width forming acute angle between row of holes and columella proper, in posterior part forming broad convex shelf protruding over margin of shell, which forms ledge below row of holes. Color uniform; often rust red from east coast, and frequently white from west coast (these differences are caused by changes in algae consumed). Spire region usually eroded by scouring or boring organism, showing blueish nacre. Nacre with milky base color, patches

with blue and green pigment color, and irregular dark conchiolin deposits. Nacre in spire region usually without red pigment. Muscle scar with indistinct border, broad spiral striation, and irregular crenulation.

***Haliotis spadicea* Donovan, 1808.** (Figure 2)

The second most common abalone species in South Africa, often called the “blood spotted abalone”, is found in shallow subtidal areas and is distributed widely from Jeffreys Bay south to Cape of Good Hope. This species has a very pronounced region of reddish pigment in spire areas in both dorsal and ventral surfaces. Usually dark reddish brown to almost black in color, it does not appear to show indications of diet influenced banding, but has strong genetic whitish irregular markings, particularly in younger stages of growth.

Description. Adults: Shell medium sized (to 105 mm RKC), elongate oblong, light to medium weight, arched, convex. Shell inflated around spire. Spire little elevated, somewhat visible in ventral view. Anterior margin characteristically undulating. Holes large, round, flush with surface of shell, usually 6–9 open. Dorsal surface smooth, with spiral depression between suture and row of holes. Some with irregular radial folds. Columella narrow. Color uniformly rust, between row of holes and columella radial banding in washed out rust and light blue. Nacre with light blue tint, in area of spire usually red pigment color. No muscle scar.

***Haliotis parva* Linnaeus, 1758.** (Figure 3)

The most common of the three smaller highly colored abalone species prized by collectors. Occasional specimens may be confused with *H. alfredensis*, but the strong mid-dorsal raised rib differentiates it. *Haliotis alfredensis* sometimes shows a very slightly raised area in the mid-dorsal region, but is much less pronounced than *H. parva*. Shells that appear to show

characteristics intermediate between these two species are known, but are extremely rare. Confirmation of hybrid status awaits study of an animal, which thus far remains unknown.

Description. Shell small to medium size (to 59 mm: DDC), lightweight, little arched, little convex, somewhat elongated, anterior margin slightly curved. Holes medium sized, round, elevated, usually 4–7 open. Dorsal surface with fine spiral threads. Threads subdivided into minute rectangular areas giving slightly scaly appearance. Single, spiral, rounded ridge at approximately $\frac{2}{3}$ to $\frac{3}{5}$ from the suture towards row of holes. A blunt ledge occurs between row of holes and columella. Columella narrow to medium width. Coloration variable: usually mottled in two colors; colors include brown, dark and light red, dark and light green, cream, off-white; blotchy mottling or with triangular elements. Unicolor specimens also known. Rarely, specimens will illustrate areas of diet banding. Solid orange specimens regularly encountered. Nacre bright white. No muscle scar.

***Haliotis queketti* Smith, 1910.** (Figure 4)

This species is considered by many to be the world’s most beautiful species of *Haliotis* due to its extreme variations in color and genetic patterns and markings.

Description. Shell small to medium sized (to 52 mm: BOC), rounded, lightweight, little arched, little convex. Spire strongly elevated, fully visible in ventral view. Holes medium sized, round, strongly elevated and tubular, usually 4–5 open. Dorsal surface occasionally with somewhat weak spiral ridge approximately in the middle between suture and row of holes, with regular radial folds from suture to spiral ridge, with faint spiral cords, occasionally with scaly ribs. Area between row of holes and columella with approximately four distinct

ledges bearing crenulations to scaly ribs, the dorsal most being the largest. Lateral area in smooth transition to columella. Color blood red, orange, dark green with cream prosocline rays, or with blotches, often in radial arrangements; banding pattern between row of holes and columella. Solid orange specimens occasionally encountered. Nacre blue with strong magenta sheen, with radial markings and usually with spiral depression. No muscle scar.

***Haliotis alfredensis*: Bartsch, 1915.** (Figure 5) Easily the rarest and most sought by collectors of all South African *Haliotis*, this species was long listed as *H. speciosa*, Reeve, 1846, due to a mistake in the literature made sometime in the 19th century. Owen discovered the error on a visit to the British Museum of Natural History in 2005. The syntypes of *H. speciosa* actually represent a species that is distributed in the Dakar area of Senegal, West Africa. This left the East African Transkei coast species with the later name *H. alfredensis* placed on it by Bartsch in 1915.

Description. Shell small to medium sized (to 79 mm: BOC), oval, medium weight, little arched, little convex. Spire little elevated, somewhat visible in ventral view. Holes medium sized, round to oval, somewhat elevated, usually 6–8 open. Dorsal surface with fine, somewhat irregularly spaced spiral threads, with a subtle spiral depression a little closer to the row of holes than to suture. Color dull red, brown, and sepia, with blotches of white, cream, or green; occasionally with finely mottled spiral bands; some specimens unicolor, solid orange form very rare. Columella narrow. Nacre bright with steel-blue sheen, usually with indistinct spiral depression. No muscle scar.

DISCUSSION As noted, a genetic solid orange color phase exists with three of these abalone species, *H. parva*, *H. queketti*, and *H.*

alfredensis. This solid orange color phases is most commonly observed with *H. parva* (perhaps as often as 10%), and less often found in *H. alfredensis* and *H. queketti*. Four specimens of this color phase are illustrated in the center rows of their species respective figures. This color phase has not been observed with either *H. midae* or *H. spadicea*.

A sixth abalone species, *H. pustulata* Reeve, 1846, may exist in the extreme northern part of South Africa; in the Durban area and at Park Rynie, along the coast of Natal. (Alwyn Marais, Werner Massier, Dawn Brink, and Steve Browning, personal communications). However, *H. pustulata* is generally recognized as a western Indian Ocean species and the few shell fragments, whole beach shells, and one or more live-taken specimens of this species found in the past 30 years suggest that it is extremely rare in this southern most extreme of the species' range.

ACKNOWLEDGEMENTS We thank Mark Jones, Dwayne Dinucci, and the late Robert Kershaw for allowing us to photograph their specimens, and Arjay Raffety for proof reading.

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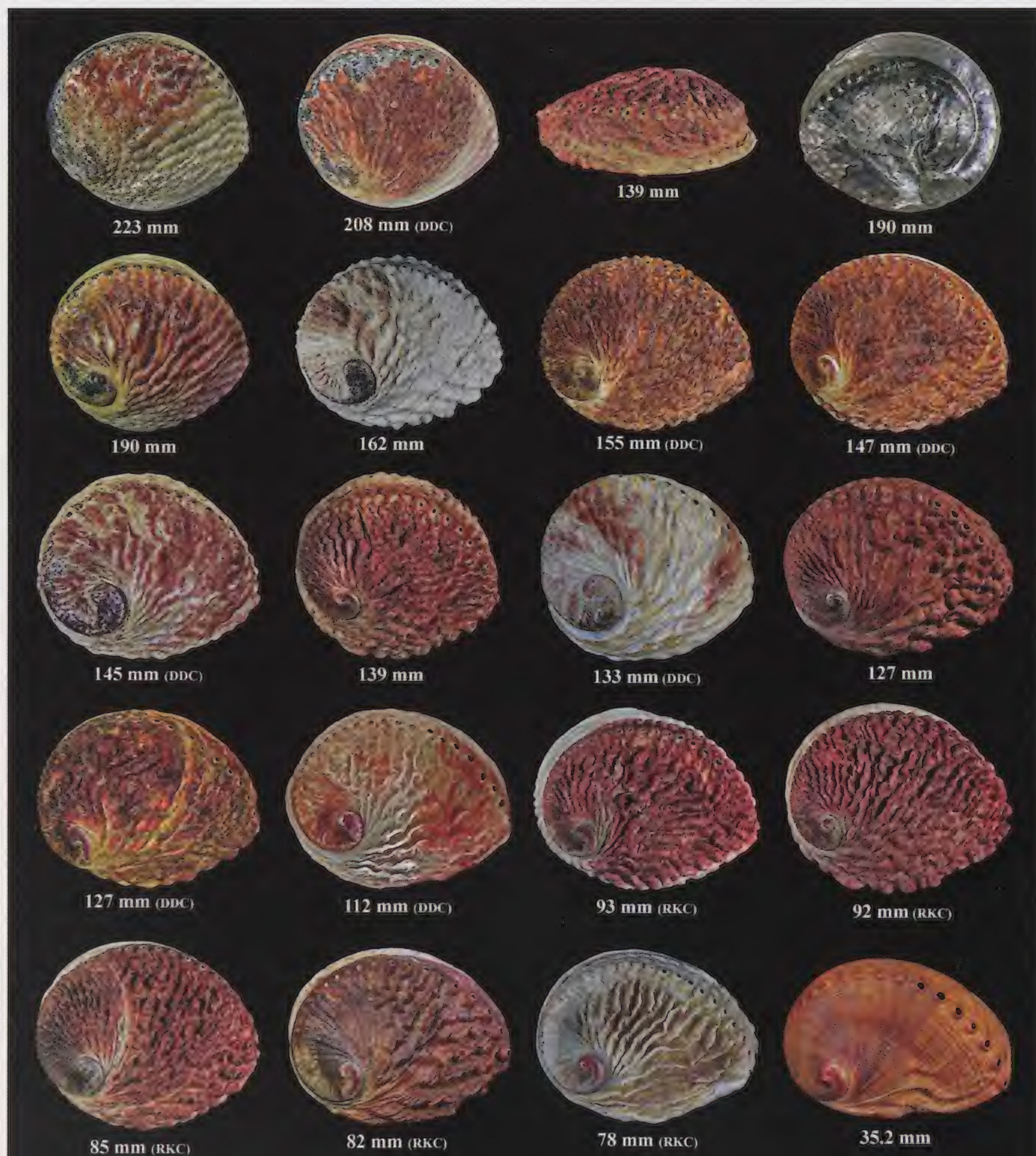
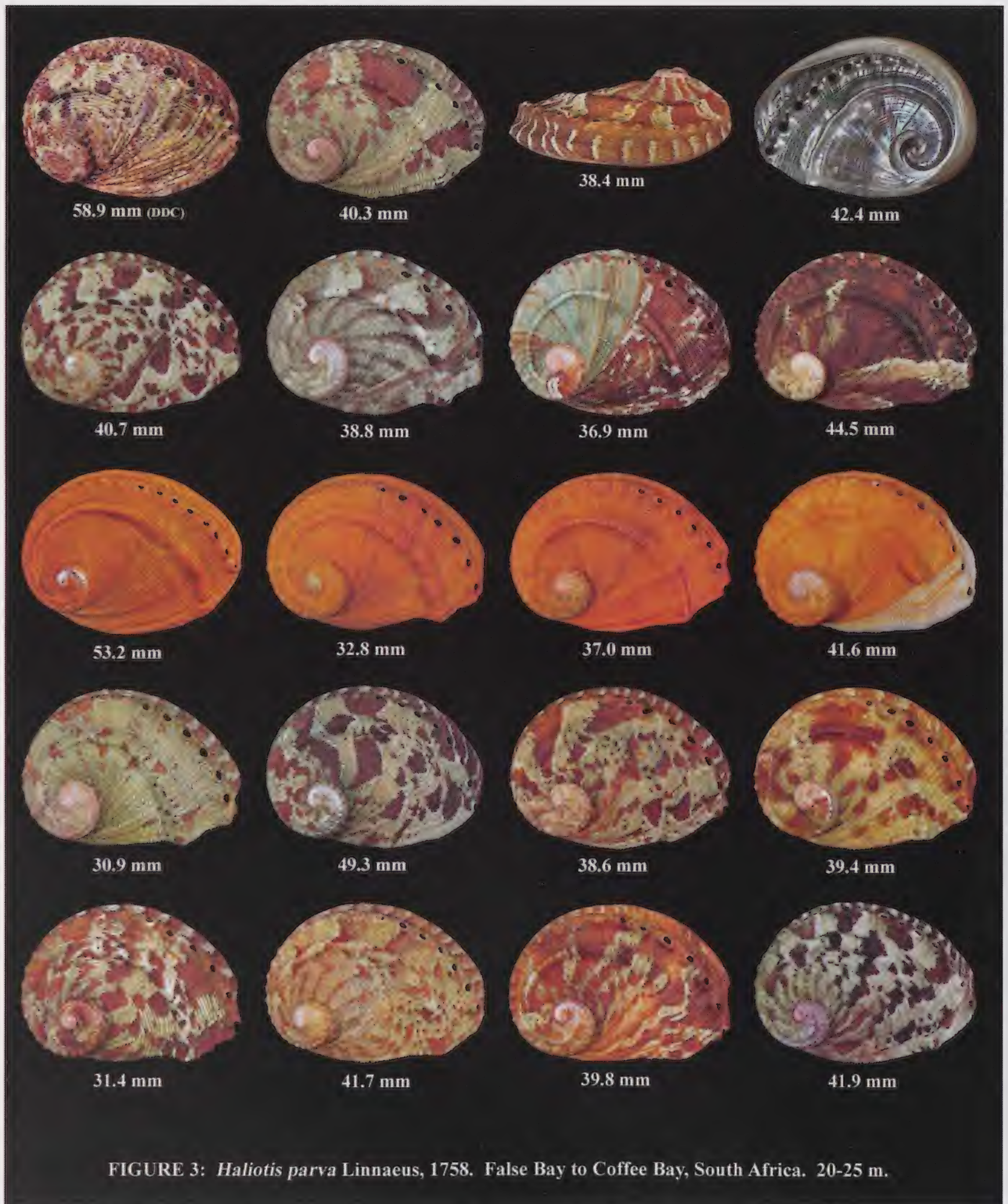


FIGURE 1: *Haliotis midae* Linnaeus, 1758. Cape Town to Jeffreys Bay, South Africa. 5-15 m.







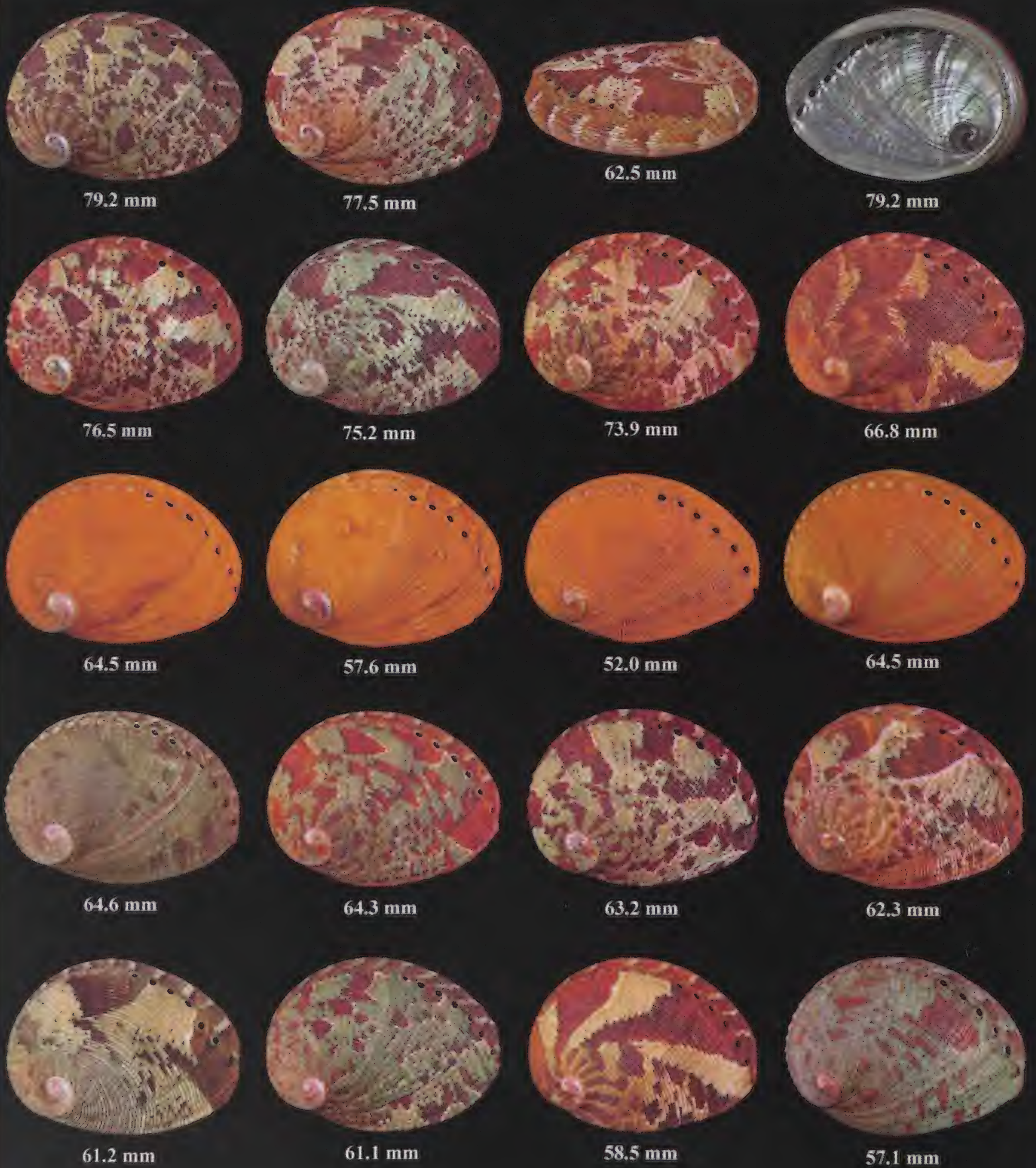
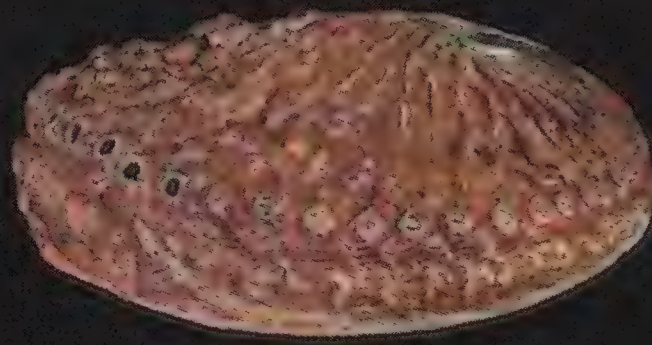
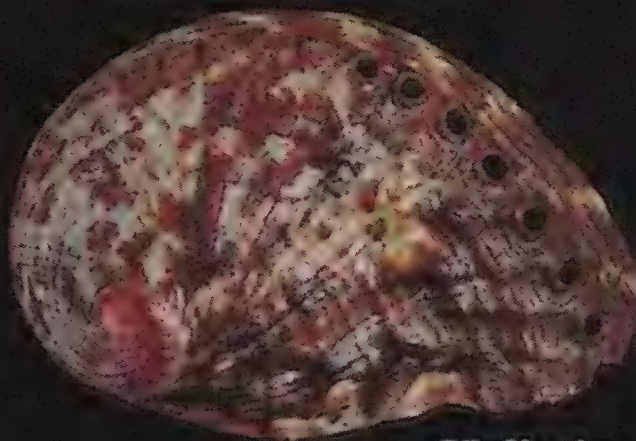


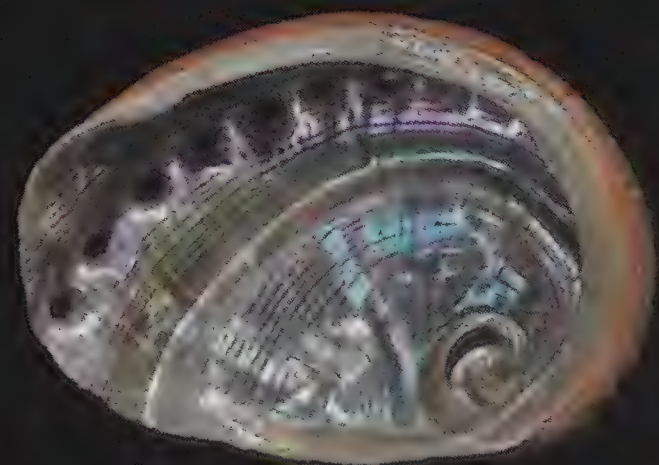
FIGURE 5: *Haliotis alfredensis* Bartsch, 1915. Coffee Bay to Xora, Transkei, South Africa. 20-25 m.



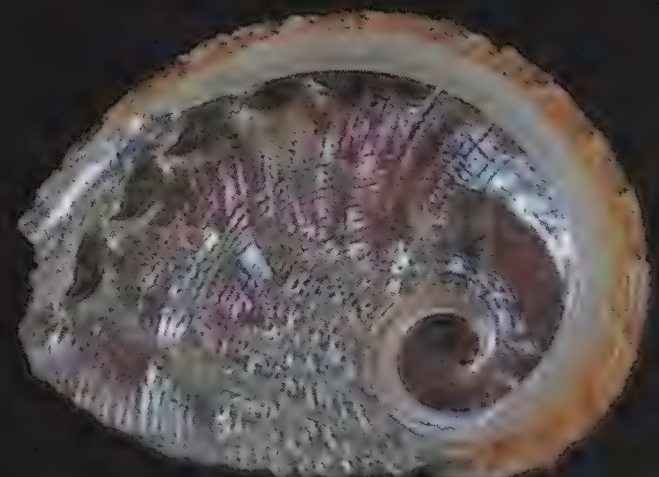
Haliotis midae Linnaeus, 1758. 127 mm. Port Elizabeth. 5-15 m.



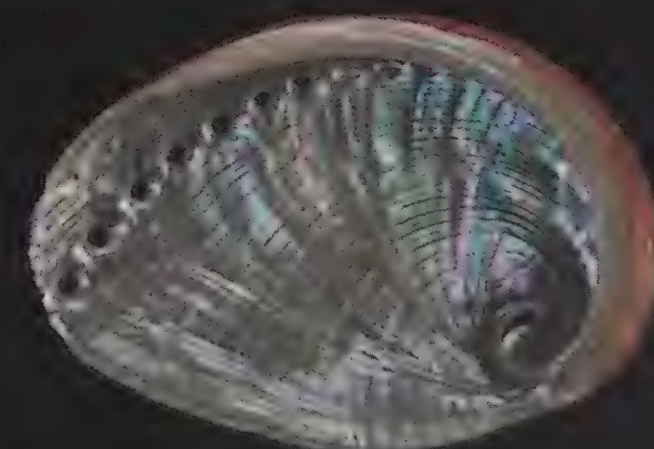
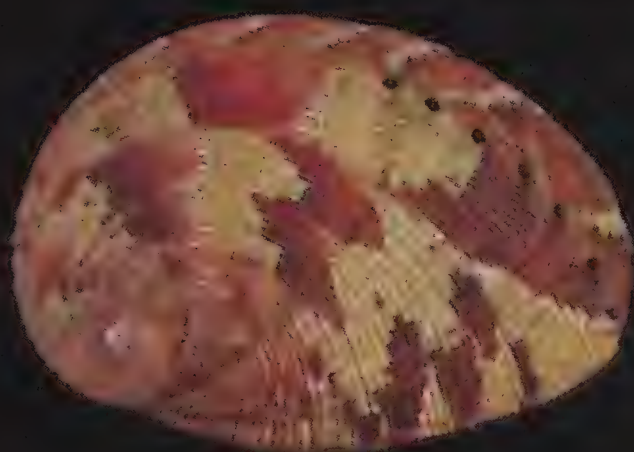
Haliotis spadicea Donovan, 1808. 41.8 mm. Mossel Bay. 1-5 m.



Haliotis parva Linnaeus, 1758. 38.4 mm. Jeffreys Bay. 10-20 m.



Haliotis queketti Smith, 1910. 33.5 mm. Coffee Bay, Transkei. 10-20 m.



Haliotis alfredensis Bartsch, 1915. 60.5 mm. Coffee Bay, Transkei. 15-25 m.

FIGURE 6. Differential Diagnostic plate of the five species of South African *Haliotis*.

Ten New Cone Shells from Indonesia, the Marquesas Islands, Brazil, and Pacific Panama

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ABSTRACT Preliminary research for an upcoming book on the molluscan biogeography and biodiversity of tropical seas has uncovered ten new cone shells, all of which are highly restricted in their ranges and are considered to be important biogeographical index species. These new taxa encompass nine new species and one new subspecies and include: *Pionoconus easoni* new species (Marquesas Islands), *Poremskiconus tourosensis*, new species (Brazil), *Cylinder abbas johnabbasi*, new subspecies (Indonesia), *Jaspidiconus crabosi*, new species (Brazil), *Jaspidiconus icapui*, new species (Brazil), *Jaspidiconus itapua*, new species (Brazil), *Jaspidiconus joanae* new species (Brazil), *Jaspidiconus keppensi* new species, (Brazil), *Coltroconus bianchii*, new species (Minerva Seamount, Brazil), and *Ximeniconus gubernatrix*, new species (Pacific Panama).

KEY WORDS Conidae, *Pionoconus*, *Poremskiconus*, *Cylinder*, *Jaspidiconus*, *Ximeniconus*, Marquesas Islands, Indonesia, Brazil, Panama.

INTRODUCTION

While compiling biodiversity data for an upcoming book on marine molluscan biogeography ("Illustrated Guide to Marine Molluscan Biogeography: Tropical and Warm Temperate Areas"; Petuch, Berschauer, and Myers, in preparation), many important new biogeographical index mollusks, including ten previously-undescribed cone shells, were brought to our attention. Several inspired amateur malacologists, including Damaso Monteiro (Brazil and Portugal), John Abbas (Indonesia), Olivier Crabos (Brazil), and Marcus and Jose Coltro (Miami, Florida and Brazil), have accumulated these new species over the past few years and generously donated these to us to be added into our data banks. These undescribed cones came from four different oceanic regions and marine climates, including the Indonesian coral reef complexes,

the isolated Marquesas Islands of the central Pacific, and the coralline algal banks, offshore seamounts, coastal sand flats of northern and central Brazil, and the multiple embayments and gulfs off the Pacific coast of Panama. Once described, these new taxa will be added to the new biogeography book and will be considered to be primary biogeographical indicator species.

The new taxa encompass nine new species and one new subspecies and include: (Conidae; Coninae) *Pionoconus easoni* new species (Nuku Hiva Is., Marquesas Islands), *Poremskiconus tourosensis* new species (northern Brazil), and *Cylinder abbas johnabbasi* new subspecies (Indonesia), and (Conidae; Conilithinae) *Jaspidiconus crabosi* new species (central Brazil), *Jaspidiconus icapui* new species (northern Brazil), *Jaspidiconus itapua* new species (central Brazil), *Jaspidiconus joanae* new species (northern Brazil), *Jaspidiconus keppensi* new species (central Brazil),

Coltroconus bianchii (Minerva Bank, Brazil), and *Ximeniconus gubernatrix* (Pacific coast of Panama). These new cones are described in the subsequent sections of this paper. The holotypes are deposited in the following institutions, depending on country of origin: in the type collection of the Department of Malacology, Los Angeles County Museum of Natural History, Los Angeles, California (and bearing LACM catalog numbers); in the Zoology Department of the National Museum of Natural History, Paris, France (Museum National d'Histoire Naturelle; and bearing MNHN catalog numbers); and in the Zoological Museum of the University of Sao Paulo, Sao Paulo, Brazil (bearing MZSP catalog numbers).

SYSTEMATICS

Class Gastropoda

Subclass Sorbeoconcha

Order Prosobranchia

Infraorder Neogastropoda

Superfamily Conoidea

Family Conidae

Subfamily Coninae

Genus *Pionoconus* Moerch, 1852

Pionoconus easoni Petuch and Berschauer,
new species

(Figures 1, 11 A-D)

Description. Shell small for genus, averaging around 30 mm, cylindrical, stocky, with slightly convex sides, widest at area immediately anterior of shoulder angle; shoulder sharply angled, bordered by large, broad, rounded carina; spire low, broadly pyramidal, with spire whorls always being slightly indented and subcanaliculate; body whorl smooth and shiny, ornamented with 12-14 small, low, evenly-spaced, thin spiral cords around anterior half; spire whorls ornamented with 4 thin spiral cords; shell color dark khaki-brown, overlaid with 18-20 dark brown, widely-spaced spiral lines;



Figure 1. *Pionoconus easoni* n. sp. Holotype 30.0 mm.

khaki-brown base color also overlaid with scattered large light blue longitudinal patches and flammules, arranged in zig-zag fashion or in widely-separated rectangular blotches; light blue zig-zag flammules marked with rows of dark brown and white dots and dashes that correspond to dark brown lines on khaki-brown areas; anterior tip of body whorl white; spire whorls dark brown, marked with very numerous, evenly-spaced light blue crescent-shaped flammules; edge of shoulder carina marked with conspicuous band of alternating dark brown and light blue patches; aperture proportionally

narrow, widening slightly toward anterior end; interior of aperture white; early whorls and protoconch colored pale tan-orange; protoconch exserted, mammilate, composed of 2 whorls; periostracum thin, smooth, and translucent.

Type Material. HOLOTYPE - length 30.0 mm, width 16.2 mm, MNHN IM-2000-33809; from Taioha'e Bay, Nuku Hiva Island, Marquesas Islands, French Polynesia (Figure 11 A, B); OTHER MATERIAL EXAMINED - lengths 35 mm and 28 mm, from the same locality as the holotype, in the research collection of the senior author; length 29 mm, from the same locality as the holotype, in the research collection of the junior author; length 27 mm, from the same locality as the holotype, in the collection of Robert L. Eason, Sr. (Paris, Tennessee, USA).

Type Locality. Found under dead coral on a reef platform in Taioha'e Bay, Nuku Hiva Island, Marquesas Islands, French Polynesia.

Distribution. At present, known only from the Marquesas Islands, French Polynesia.

Ecology. At Taioha'e Bay on Nuku Hiva Island, *Pionoconus easoni* inhabits coral rubble areas on carbonate platforms, in the intertidal zone and in shallow subtidal depths (1 - 2 m). Belonging to a piscivorous genus, the new species is assumed to be a predator on small blennioid and gobioid fishes. More exploration in the Marquesas may show that this new species is widely distributed on other islands, such as Fatu Hiva, Hiva Oa, and Eiao.

Etymology. Named for Robert L. Eason, Sr. of Paris, Tennessee, USA, avid amateur naturalist and malacologist, who assisted the senior author with field work in the Ten Thousand Islands of Florida.

Discussion. On Nuku Hiva Island, this new endemic Marquesan *Pionoconus* species is sympatric with *Pionoconus catus* (Hwass, 1792)

(Figure 11 E, F) and the two species may be competing for the same fish prey. A similar situation, where two small *Pionoconus* species occur together in the same habitat, is seen in the Philippines, Thailand, and Melanesia. Here, the widespread Indo-Pacific *P. catus* is sympatric with the similar-sized *P. decurtatus* (Dautzenberg, 1910) and the two sibling species often occur side-by-side on intertidal reef flats (E.J. Petuch, personal observation; as seen at Rossel Island, Louisiade Archipelago, Papua-New Guinea). Likewise in Tanzania and Kenya, the small *Pionoconus striolatus* (Kiener, 1845) is also found on exposed reef flats living sympatrically with *P. catus*, as is the similar *P. vinctus* (A. Adams, 1855) along the northern Australian coast. This biogeographical pattern of a wide-ranging species (*P. catus*) living together with a geographically-restricted species (*P. easoni*, *P. decurtatus*, *P. vinctus*, and *P. striolatus*) is now known to occur at several areas of the Indo-Pacific Region, including East Africa, the Indonesian-Malaysian Archipelago, northern Australia, Melanesia, and the isolated Marquesas Islands.

In shape, size, and basic color pattern, *Pionoconus easoni* is most similar to the Indonesian, Philippine, and Melanesian *P. decurtatus*, but differs in being a more darkly-colored shell with larger dark brown areas on the body whorl, in having fewer and more widely-spaced dark brown spiral lines on the body whorl, in having a more darkly-colored spire with a dark brown base color marked with numerous pale blue crescent-shaped flammules, and in having the shoulder carina marked with a conspicuous band of alternating dark brown and pale blue checkers. The new species is also similar in appearance to the northern Australian *P. vinctus* in having the prominent dark brown spiral lines on the body whorl, but differs in being a smaller and stockier shell and in having large light blue longitudinal flammules.

Although occurring together with *P. catus* on Nuku Hiva (Figure 11 E, F), the new species can be easily separated from its sibling species by having a much more slender and distinctly cylindrical shell. The sympatric *P. catus* has a much broader and more pyriform shell with a proportionally much wider shoulder, which tapers abruptly to the anterior tip. As in *P. easoni*, *P. catus* has numerous raised spiral cords around the anterior half of the body whorl, but these are proportionally much larger and coarser than those seen on the new Marquesan species. In *P. easoni*, these cords are smooth and adherent to the body whorl, while those of *P. catus* are characteristically heavily ornamented with large raised pustules and are always more prominently raised.

Pionoconus easoni is the newest member of a morphologically closely-knit Indo-Pacific radiation that includes nine other species: *P. decurtatus* (Dautzenberg, 1910) (Philippines, Indonesia, and Melanesia), *P. vinctus* (A. Adams, 1855) (northern Australia); *P. striolatus* (Kiener, 1845) (East Africa, Indian Ocean); *P. koukai* (Monnier, Limpalaer, and Robin, 2013) (Oman); *P. nigropunctatus* (Sowerby II, 1858) (Red Sea); *P. nigropunctatus elatensis* (Wils, 1971) (Gulf of Aqaba); *P. simonis* (Bozzetti, 2010), (SE Madagascar); *P. rouxi* Monnier, Limpalaer, and Robin, 2013) (northwestern Australia); and *P. morrisoni* (Raybaudi Massilia, 1991) (Ashmore Reef and Cartier Islands, Australia). This species group of small, stocky reef-dwelling taxa is now known to range from the Red Sea and eastern Africa to the Marquesas Islands, extreme eastern Polynesia. The type lot of *P. easoni* was purchased from Rika Goethaels and Fernand DeDonder, Peutie, Belgium, from a small mixed collection of *P. catus* and *P. easoni* that had been commercially collected on Nuku Hiva.

Genus *Poremskiconus* Petuch, 2013

Poremskiconus tourosensis Petuch and Berschauer, new species
(Figures 2, 11 G, H)



Figure 2. *Poremskiconus tourosensis* n.sp. Holotype 16.7 mm.

Description. Shell small for genus, averaging 18 mm, stocky, slightly rotund, with distinctly convex sides; shoulder sharply angled, bordered with wide rounded carina; spire low, broadly subpyramidal, with early whorls projecting and exserted; spire whorls obsolete scalariform, with indented sutures; body whorl smooth and polished, ornamented with 6-8 large spiral cords

around anterior end; spire whorls smooth, ornamented with extremely faint small spiral threads; body whorl color bright orange red, overlaid with large white patches and zig-zag flammules, primarily arranged around mid-body; spire whorls white, marked with large, evenly-spaced and widely-separated orange-red flammules; edge of shoulder carina marked with row of small alternating white and reddish-tan spots, producing checkered pattern; aperture narrow throughout, slightly arcuate; interior of aperture uniformly pale orange red; protoconch and early whorls bright red; protoconch mammilate, composed of two whorls.

Type Material. HOLOTYPE - length 16.7 mm, width 9.3 mm, MZSP 135606; from off the coast of Touros, Rio Grande do Norte State, Brazil; OTHER MATERIAL EXAMINED - length 18 mm, from the same depth and locality as the holotype, in the research collection of the senior author; length 18 mm, from the same depth and locality as the holotype, in the research collection of the junior author.

Type Locality. Collected by divers, from 10 - 15 m depth, on a coralline algal sea floor off Touros, Rio Grande do Norte State, Brazil.

Distribution. At present, known only from the coralline algal reefs off Touros, Rio Grande do Norte State, Brazil.

Ecology. The new species lives among and beneath coralline algal rhodoliths (coral-like masses formed by the red coralline algae *Lithothamnion*, *Lithophyllum*, and *Sporolithon*) in depths of 10 to 15 m.

Etymology. Named for the city of Touros, Rio Grande do Norte State, Brazil, the locality where this new species was first collected.

Discussion. *Poremskiconus tourosensis* is morphologically closest to *P. mauricioi* (Coltro, 2004) from northeastern Brazil (Piaui and Ceara States), but differs in being a smaller, more slender shell with a proportionally higher spire and in lacking the prominent and conspicuous dark brown and white flammules seen on the spire and shoulder carina of *P. mauricioi*. The new species also differs from the variably-colored *P. mauricioi* (which comes in red, brown, yellow, and green color morphs) in being relatively invariant in color, exhibiting only a red or red-orange base color.

This distinctive bright red algal reef-dwelling species is the newest member of a remarkable species radiation of *Poremskiconus* that is restricted to northern Brazil (Maranhao, Piaui, Ceara, and Rio Grande do Norte States; the Cearaian Subprovince of the Brazilian Molluscan Province). Some of the other members of this northern Brazilian species complex include the recently-described *Poremskiconus fonsecai* Petuch and Berschauer, 2016, *P. smoesi* Petuch and Berschauer, 2016, *P. mariaodeteae* Petuch and Myers, 2014, and the previously-discussed *P. mauricioi* (see Petuch and Berschauer, 2016 for a partial overview of the genus in northern Brazil).

Genus *Cylinder* Montfort, 1810

Cylinder abbas johnabbasi Petuch and
Berschauer, new subspecies
(Figures 3, 12 A, B)

Description. Shell of average size for genus, fusiform and elongated, inflated, with slightly convex sides; spire proportionally low, broadly subpyramidal; shoulder sharply-angled, edged with small, slightly-raised carina; body whorl smooth, with silky texture; body whorl white, completely overlaid with dense dark brown netted pattern, composed of interconnected

small triangles, ovals, and amorphous shapes; some larger amorphous nettings anastomosing into larger irregular shapes or into elongated longitudinal zig-zag patterns that extend for entire length of shell; 2 thin bands of small brown or tan patches extend around body whorl, with both arranged on either side of mid-body line; spire whorls white, covered with irregular zig-zag lines and scattered small brown patches; early whorls exserted, red-orange in color; aperture proportionally wide, white within.

Type Material. HOLOTYPE - length 55.0 mm, width 27.5 mm, LACM 3499; from off the coast of Pangandaran, Java Island, Indonesia; OTHER MATERIAL EXAMINED - lengths 55 mm and 72 mm, from the same locality as the holotype, in the research collection of the senior author; 5 specimens, lengths 59 mm to 76 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. The new subspecies was collected in fishermen's nets ("tango nets"), from a muddy black sand sea floor, in 10-12 m depth off the mouth of the Cainjong River, which empties into the western bay of Pangandaran, Java, Indonesia (John Abbas, personal communication).

Distribution. At present, known only from Java and Bali Islands, Indonesia, but may be present on other neighboring Indonesian islands.

Ecology. The new subspecies lives on organic-rich muddy black sand sea floors, in 10 - 12 m depths, near the mouths of silt-laden rivers.

Etymology. Named for John Abbas of Djakarta, Java, Indonesia, inspired amateur naturalist, photographer, and exploratory malacologist, whose discoveries have added much to our knowledge of the Indonesian malacofauna, both marine and terrestrial.

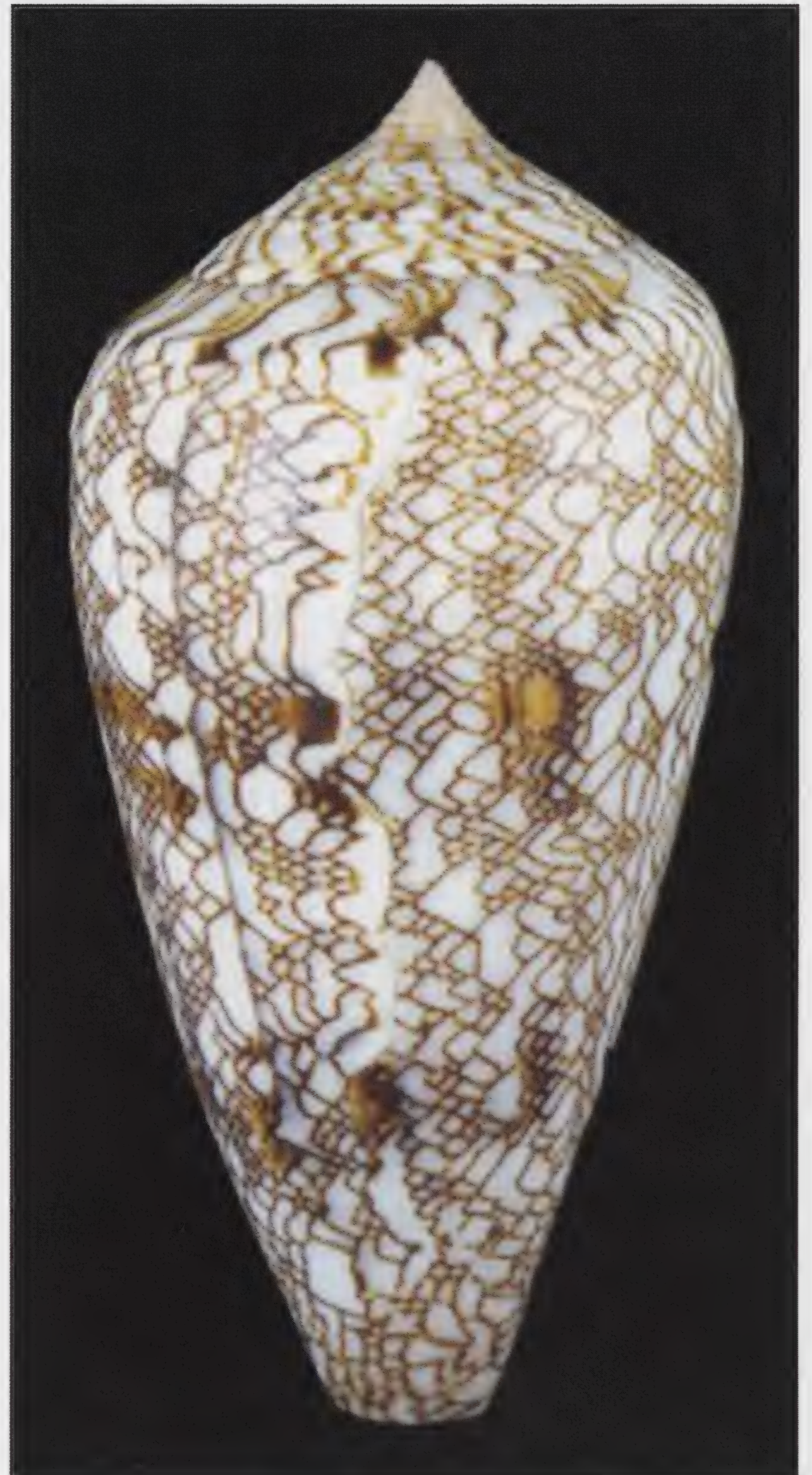


Figure 3. *Cylinder abbas johnabbasi* n.ssp. Holotype 55.0 mm.

Discussion. This new taxon is proposed as a geographically-isolated subspecies of *Cylinder abbas* (Hwass, 1792) (Figure 12 C). The nominate subspecies, *abbas abbas*, is confined to Sri Lanka and southeastern India and differs from the Indonesian *abbas johnabbasi* in being a much less elongated and more compact and truncated shell, in having a much finer and more

regular netted pattern, and in having a much more darkly-colored shell, with larger and more prominent brown patches arranged in two rows. The netted pattern of *abbas johnabbasi* is composed of larger triangles and ovals than those seen on *abbas abbas* and these often coalesce to form elongated zebra stripes or zig-zags. This type of variable net pattern is never seen on the nominate subspecies.

Hwass originally designated the type locality of *Cylinder abbas* as “East Indies”, which is far too vague and could refer to any area from India to Indonesia. The neotype specimen of *C. abbas* (shown here on Figure 12 D) also had no type locality designation, but is obviously a typical Sri Lankan specimen. For the sake of taxonomic clarity, we here designate the type locality of *Cylinder abbas abbas* as “Trincomalee, Sri Lanka”, a well-known area where classic specimens of the nominate subspecies have been collected for decades. The 2004 tsunami resulted in the death of many of the Sri Lankan commercial shell collectors and the nominate subspecies is now rarely offered for sale.

Subfamily Conilithinae

Genus *Jaspidiconus* Petuch, 2004

Jaspidiconus crabosi Petuch and Berschauer,
new species
(Figures 4, 12 E, F)

Description. Shell of average size for genus, subcylindrical, broad across shoulder; spire proportionally high, pyramidal, distinctly scalariform; shoulder sharply angled, edged with thin, blade-like carina; spire whorls slightly indented and canaliculated; body whorl polished and shiny, sculptured with 2 types of ornamentation; posterior half of body whorl sculptured with 6 large, evenly-spaced spiral cords that are ornamented with large bead-like pustules; anterior half of body whorl sculptured

with 12 smaller, flatter, and smoother spiral cords that lack large pustules; shell color uniform pale violet purple overlaid with widely scattered small, thin brown longitudinal flammules and small brown spots; edge of shoulder carina marked with row of tiny, widely-spaced brown dots; spire whorls paler whitish-lavender in color; aperture proportionally narrow, widening toward anterior end; aperture white, becoming pale purple within interior.



Figure 4. *Jaspidiconus crabosi* n.sp. Holotype 20.6 mm.

Type Material. HOLOTYPE - length 20.6 mm, width 11.4 mm, MZSP 135600; found on sand flats along the shoreline of Boipeba Island, Bahia State, Brazil; OTHER MATERIAL EXAMINED - lengths 19 mm and 22 mm, from the same locality as the holotype, in the research collection of the senior author; length 17.6 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. Found dead on sand flats off the shoreline of Boipeba Island, Bahia State, Brazil.

Distribution. At present, known only from the coastal areas of Boipeba Island, south of Todos os Santos Bay, Bahia State, Brazil.

Ecology. Although collected in a freshly dead condition, the type lot was found along a stretch of sand beach near large extensive sand flats. The new species is most probably an inhabitant of open clean sand sea floors, in intertidal depths.

Etymology. Named for Olivier Crabos, Salvador, Bahia State, Brazil, inspired amateur malacologist who has discovered several new cone shells while collecting in unexplored areas along the Bahia coastline.

Discussion. Of the known Brazilian Province *Jaspidiconus* species, *J. crabosi* is morphologically most similar to *J. ogum* Petuch and Myers, 2014 from Itaparica Island in Todos os Santos Bay, but differs in being a much stockier and more inflated shell that is wider across the shoulder. The pustulated cords on the body whorl of the new species are also proportionally thinner and farther apart, with the pustules being smaller and more numerous. The split sculpture pattern of *J. crabosi*, with pustulated cords on the posterior of the body whorl and smoother non-pustulated cords on the anterior half, is distinctive and is not seen on *J.*

ogum. The characteristic pale purple or violet shell color of the new species is also not seen on *J. ogum*, which are most often bright orange, yellow, orange-tan, or reddish-orange.

Jaspidiconus icapui Petuch and Berschauer,
new species
(Figures 5, 12 G, H)

Description. Shell of average size for genus, rotund and stocky, subturbinate, with inflated body whorl and rounded sides; spire proportionally high and elevated, pyramidal;



Figure 5. *Jaspidiconus icapui* n.sp. Holotype 15.1 mm.

shoulder sharply-angled, edged with thin carina; body whorl smooth and polished, sculptured with 10-12 widely-separated, shallow incised sulci around anterior two-thirds; body whorl base color pale cream-tan or yellowish-tan, overlaid with 2 bands of widely-separated rectangular or oval light brown patches, one around mid-body and one around the anterior end; spire whorls cream-tan, marked with large, conspicuous amorphous dark orange-tan flammules; protoconch and early whorls pale orange; aperture proportionally narrow, widening toward anterior end, pale tan within interior.

Type Material. HOLOTYPE - length 15.1 mm, width 11.4 mm, MZSP 135601; from off Icapui, Ceara State, Brazil; OTHER MATERIAL EXAMINED - lengths 16 mm and 18 mm, from the same locality as the holotype, in the research collection of the senior author; length 17.6 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. The type lot was dredged from 30-40 m depths off Icapui, Ceara State, Brazil.

Distribution. At present, known only from the deeper offshore waters of Ceara State, Brazil.

Ecology. The new species was collected on a coralline algal rubble and carbonate sand sea floor, at 30 - 40 m depths.

Etymology. Named for the city of Icapui, Ceara State, Brazil, the locality from which the new species was first collected. The taxon is a noun in apposition, based upon a Native American place name.

Discussion. Of the known northern Brazilian *Jaspidiconus* species, *J. icapui* is morphologically similar only to *J. damasomonteiroi* Petuch and Myers, 2014, from

the deep water coralline algal bioherms off Ceara State and the Canopus Bank (for a discussion of Brazilian *Jaspidiconus* species, see Petuch and Myers, 2014). The new species differs from its deeper water congener in being a much smaller shell with a more rotund and turnip-like shape, and in being a smoother and much less sculptured shell that lacks the large and heavy pustules found on *J. damasomonteiroi*.

Jaspidiconus itapua Petuch and Berschauer,
new species
(Figures 6, 13 A, B)

Description. Shell of average size for genus, cylindrical, with straight sides that curve inward abruptly at anterior end; shoulder sharply-angled with thin, blade-like carina; shoulder carina sculptured with 14-16 low, undulating knobs; spire elevated and pyramidal; body whorl smooth and polished, ornamented with 16-18 very thin and faintly-impressed spiral sulci, which become increasingly stronger and better-developed toward the anterior end; shell base color orange or orange-tan, overlaid with variable amounts of large darker orange or tan amorphous flammules; pale whitish-orange or white band present just anterior of the mid-body line on body whorl; spire whorls whitish-orange or whitish-yellow, marked with irregularly-spaced dark orange oval-shaped flammules; early whorls and protoconch pale orange; aperture proportionally narrow, flaring widely toward the anterior end; interior of aperture bright orange or orange-tan.

Type Material. HOLOTYPE - length 14.4 mm, width 8.0 mm, MZSP 135602; from Farol de Itapua, Itapua, Bahia State, Brazil; OTHER MATERIAL EXAMINED - 3 specimens, lengths 18 mm - 21 mm, from the same locality of the holotype, in the research collection of the senior author; lengths 16.7 mm and 12.7 mm,

from the same locality as the holotype, in the research collection of the junior author.

Type Locality. Collected on the beach at the Farol de Itapua, Itapua, Bahia State, Brazil.

Distribution. At present, known only from the area around Itapua, Bahia State, Brazil.



Figure 6. *Jaspidiconus itapua* n.sp. Holotype 14.4 mm.

Ecology. Although collected as dead beach specimens, the type lot most probably lived on the shallow (1 - 3 m) coarse quartz sand sea floor immediately offshore of the Itapua

Lighthouse (Farol de Itapua). *Jaspidiconus itapua* occurs together sympatrically with the much larger *J. josei* Petuch and Berschauer, 2016 along the Itapua coast.

Etymology. Named for the city of Itapua, Bahia State, Brazil, the locality from which the first specimens of this new species were collected. The taxon is a noun in apposition, based upon a Native American place name.

Discussion. Of the known northern and northeastern Brazilian *Jaspidiconus* species, *J. itapua* only resembles *J. damasoi* (Cossignani, 2007) from the coralline algal sea floors off Ceara State (see Petuch, 2013:145-148). Both species share the same bright orange and orange-tan shell colors and faintly-incised spiral sulci, but *J. itapua* differs from *J. damasoi* in being a broader, less elongated shell with a much lower spire, in having straighter sides, and in having the distinctive undulating shoulder coronations and coronated carina.

Jaspidiconus joanae Petuch and Berschauer,
new species
(Figures 7, 13 C, D)

Description. Shell of average size for genus, biconical, with stocky body whorl and broad shoulder area; spire high and elevated, distinctly pyramidal, slightly scalariform; shoulder sharply-angled, edged with sharp, blade-like carina; shoulder carina ornamented with 16-18 low, flattened undulating coronations; body whorl shiny and polished, sculptured with 15 deeply-incised spiral sulci, forming large, wide flattened cords between pairs of sulci; some cords ornamented with scattered large rounded pustules, most often best developed at posterior end of body whorl; body whorl color white, often overlaid with large tan or tan-orange, irregular, amorphous longitudinal flammules; many specimens pure white, without colored

flammules; spire whorls white, with scattered small pale-tan-orange triangular flammules; edge of shoulder carina marked with row of small orange-tan dots, with each dot being found between pair of undulating coronations on carina; early whorls and protoconch pure white; aperture proportionally wide, pure white within interior.



Figure 7. *Jaspidiconus joanae* n.sp. Holotype 16.5 mm.

Type Material. HOLOTYPE - length 16.5 mm, width 8.9 mm, MZSP 135603; from off Rio do Fogo, Rio Grande do Norte State, Brazil; OTHER MATERIAL EXAMINED - four

specimens, lengths 11 mm to 18 mm, from the same locality as the holotype, in the research collection of the senior author; lengths 13.4 mm and 13.0 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. Offshore of Rio do Fogo, Rio Grande do Norte State, Brazil.

Distribution. Known only from the Rio di Fogo area of Rio Grande do Norte State, Brazil.

Ecology. The new species prefers clean carbonate sand pockets between coralline algal knolls and banks, in 3 - 10 m depths.

Etymology. Named for Joana Fonseca de Silva, of Lisboa, Portugal, who assisted her father, Francisco Fonseca da Silva, in collecting shells along the unexplored areas of Rio Grande do Norte State.

Discussion. Of the known northern Brazilian *Jaspidiconus* species, *J. joanae* is similar only to *J. damasomonteiroi* Petuch and Myers, 2014 from Ceara State and the offshore Canopus Bank, but differs in being consistently a smaller, stockier, more turbinate, and less elongated shell, in being a less-ornamented species, having fewer and smaller pustules on the body whorl, and in being a much paler-colored shell, having a pure white base color with scattered pale tan flammules, lacking the vibrant pink, salmon, and yellow base colors of *J. damasomonteiroi*.

Jaspidiconus keppensi Petuch and Berschauer,
new species
(Figures 8, 13 E, F)

Description. Shell small for genus, stocky, wide across shoulder; spire elevated, pyramidal, slightly stepped and scalariform; shoulder

sharply-angled, edged with thin rounded carina; shoulder carina ornamented with 18-20 small rounded beads, producing coronated spire whorls; body whorl shiny, ornamented with 15-16 low, flattened, almost obsolete spiral cords; some cords have scattered small, low pustules; shallow incised sulci present between low spiral cords on body whorl; spire whorls slightly canaliculated due to raised coronated edge of carina; body whorl color pale violet or pale blue, overlaid with large brown amorphous flammules that are arranged in 2 rows, one around anterior tip and one around posterior end; early whorls and protoconch pale yellow-tan; clear unmarked band and row of darker brown patches both present around mid-body area; spire whorls pale violet-white, marked with scattered irregular small brown flammules; row of tiny thin brown flammules present along edge of suture; aperture narrow, widening toward anterior end; interior of aperture dark brown.

Type Material. HOLOTYPE - length 14.9 mm, width 8.3 mm, MZSP 135604; offshore of Alcobaca, Bahia State, Brazil; OTHER MATERIAL EXAMINED - length 15 mm, from the same locality as the holotype, in the research collection of the senior author.

Type Locality. The new species was collected in coral rubble and sand, in 2 m depth, off Alcobaca, Abrolhos Platform, Bahia State, Brazil.

Distribution. Presently known only from the Alcobaca area of the Abrolhos Platform, Bahia State, Brazil.

Ecology. *Jaspidiconus keppensi* prefers coarse carbonate sand, mixed with coral rubble, in 1 - 5 m depths, on reef platforms along the western side of the Abrolhos Platform.



Figure 8. *Jaspidiconus keppensi* n.sp. Holotype 14.9 mm.

Etymology. Named for Marc Keppens of Gavere, Belgium, inspired amateur malacologist and avid student of the Conidae.

Discussion. With its coronated spire whorls and shoulder carina, along with its corded body whorl sculpture, *Jaspidiconus keppensi* is morphologically closest to only one central Brazilian cone; *J. poremskii* Petuch and Myers, 2014 from the mouth of Todos os Santos Bay, south of Salvador. The new Abrolhos Platform

species differs from its northerly congener in being a much stockier, more compact, and less elongated shell with more rounded sides. The incised sulci and spiral cords are also better-developed, stronger, and more numerous on *J. keppensi* than on the smoother *J. poremskii*. Characteristically, *J. poremskii* has a bright orange or orange-red shell color with scattered white and yellow markings. The new species, on the other hand, is consistently a pale lavender color, overlaid with large dark brown patches, and has never been collected in any other base color.

Genus *Coltroconus* Petuch, 2013

Coltroconus bianchii Petuch and Berschauer,
new species
(Figures 9, 13 G, H)

Description. Shell tiny, of average size for genus, slender, elongated, with slightly convex sides; shoulder sharply angled, edged with row of 12 very large rounded knobs that extend beyond carinal area; spire elevated, pyramidal, distinctly scalariform and stepped; spire whorls heavily coronated; body whorl ornamented with 15-16 very large, raised spiral cords that are heavily pustulose, giving shell rough appearance; body whorl base color bright orange, overlaid with scattered small white patches and dots and often with wide white band around the mid-body; spire whorls white with scattered small dark orange patches; early whorls and protoconch pale yellow-white; protoconch proportionally very large, round, mammilate, composed of 2 whorls; aperture narrow, pale orange within interior.

Type Material. HOLOTYPE - length 11.2 mm, width 5.8 mm, MZSP 135605; Minerva Seamount, Bahia, Brazil; OTHER MATERIAL EXAMINED - lengths 9 mm and 8 mm, from the same locality as the holotype, in the research

collection of the senior author; lengths 7.4 mm and 8.9 mm, from the same locality as the holotype, in the research collection of the junior author.



Figure 9. *Coltroconus bianchii* n.sp. Holotype 11.2 mm.

Type Locality. The new *Coltroconus* was dredged, by an exploratory petroleum research vessel, at 120 m depth on the Minerva Seamount (16 degrees 59 minutes 48 seconds S, 37 degrees 33 minutes 07 seconds W), due

north of the Abrolhos Platform, Bahia State, Brazil.

Distribution. Known only from the Minerva Seamount, to which the new species is endemic.

Ecology. *Coltroconus bianchii* prefers sea floors composed of fine carbonate muds mixed with coral rubble, in depths of 100 - 200 m.

Etymology. Named for Alex Bianchi, who first collected this tiny cone and recognized it as new, while dredging on the Minerva Seamount.

Discussion. This new Minerva Seamount endemic is most similar to *Coltroconus delucai* (Coltro, 2004) from the Abrolhos Islands, having the same general size, shell shape, and coronated spire ornamentation. *Coltroconus bianchii*, however, differs from its Abrolhos congener in being a bright orange shell, as opposed to the deep blood red color of *C. delucai*, in having a much higher, scalariform spire, and in having a heavily pustulated body whorl.

Genus *Ximeniconus* Emerson and Old, 1962

Ximeniconus gubernatrix Petuch and
Berschauer, new species
(Figures 10, 13 I, J)

Description. Shell small for genus, averaging 24 mm, stocky and pyriform, wide across shoulder, with rounded convex sides; shoulder slightly rounded but angled, with sloping subsutural area; spire high and elevated, acutely subpyramidal and pagodiform; spire whorls slightly indented and canaliculate; body whorl smooth and shiny, with 10 widely-spaced, faintly-incised thin spiral sulci around anterior half; spire whorls smooth and polished; base color of body whorl pale salmon-orange overlaid with proportionally very large, closely-

packed dark orange-brown amorphous longitudinal flammules; base color pattern and large flammules overlaid with 18 - 20 evenly-spaced spiral rows of small reddish-brown dots and dashes; pale salmon-orange marked with large, irregularly-spaced amorphous brown patches and 2 rows of small reddish-brown dots, one around edge of suture and one along edge



Figure 10. *Ximeniconus gubernatrix* n.sp. Holotype 22.3 mm.

of shoulder; early whorls and protoconch pale salmon-orange; aperture proportionally narrow, white becoming pale salmon or yellow deep within interior.

Type Material. HOLOTYPE - length 22.3 mm, width 10.8 mm, LACM 3500; from sand flats off Gobernadora Island, Gulf of Montijo, Veraguas Province, Panama; OTHER MATERIAL EXAMINED - lengths 22 mm and 30 mm, from the same locality as the holotype, in the research collection of the senior author.

Type Locality. On sand flats at low tide, southern coast of Gobernadora Island, Gulf of Montijo, Veraguas Province, Panama.

Distribution. At present, known only from the Gulfs of Chiriqui and Montijo, Pacific Panama, but the species may also extend southward to the Perlas Islands and Gulf of Panama.

Ecology. The new Panamanian species prefers intertidal sand flats in quiet, protected areas within bays and coastal lagoons.

Etymology. Named as the Latin equivalent of the Spanish “Gobernadora” (Women Governor), in reference to Gobernadora Island, the type locality.

Discussion. This new species of *Ximeniconus* has been collected and sold by commercial shell dealers for years as “*Conus ximenes*” or “*Conus perplexus*”, primarily because of its spotted color pattern and its small size. *Ximeniconus gubernatrix* is morphologically closest to *X. ximenes* (Gray, 1839), but differs in being a much smaller, stockier, and more pyriform shell. *Ximeniconus ximenes* is a much larger, more distinctly cylindrical and elongated shell that has a pale violet or pure white base color, and never exhibits the pale salmon-orange base color seen on the new species. The interior of

the aperture of *X. ximenes* is a pale violet color, while that of *X. gubernatrix* is a pale salmon or yellowish-orange. The large brown patches and flammules that dominate the color pattern of the new species are never as large or prominent on *X. ximenes*, which often is devoid of any brown patches. In respect to these dark color patches, *X. gubernatrix* is similar to *X. mahogani* (Reeve, 1843), but can easily be separated from that species by being a much stockier and more truncated shell with a proportionally shorter and less elongated body whorl.

The gastropod fauna of the Panamanian coast, from the Gulf of Chiriqui to the Gulf of Panama and the Perlas Islands, is known for its high percentage of regional endemism. Other Panamanian endemics that occur in the same areas as *Ximeniconus gubernatrix* include the cassid *Cypraecassis wilmae*, the olivids *Americoliva truncata* and *Americoliva olssoni*, the cypraeids *Pseudozonaria aequinoctialis* and *Talostolida panamensis* (also Galapagos), and the conids *Globiconus baccatus* and *Dauciconus fenzi* (deep water Gulf of Chiriqui). *Ximeniconus ximenes* is a widespread species, ranging from the outer coast of Baja California and the Gulf of California, Mexico south to northern Peru, but seems to be relatively uncommon, or absent, in the Gulfs of Chiriqui and Montijo. Here, in the quiet sheltered intertidal areas between islands, the widespread *X. ximenes* appears to be replaced by the endemic *X. gubernatrix*. Although the spotted Panamic cones of the genera *Ximeniconus*, *Perplexiconus*, and *Globiconus* were discussed and illustrated in detail by Tucker (2016), no shells similar to *X. gubernatrix* were mentioned and, apparently, the new species has previously been overlooked.

ACKNOWLEDGMENTS

For the donation of valuable research specimens, we thank the following: Damaso Monteiro (Oporto, Portugal and Fortaleza, Brazil) for the type material of *Poremskiconus tourosensis*, *Jaspidiconus icapui*, *Jaspidiconus joanae*, and *Jaspidiconus keppensi*; John Abbas (Djakarta, Java, Indonesia) for the type lot of *Cylinder abbas johnabbasi*; Marcus and Jose Coltro (Miami, Florida and Sao Paulo, Brazil) for the type lot of *Coltroconus bianchii*; and Olivier Crabos (Salvador, Bahia, Brazil) for the type lot of *Jaspidiconus crabosi* and *Jaspidiconus itapua*. Without their help and generosity, this paper would never have come to fruition.

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Figure 11. New Species of *Pionoconus* and *Poremskiconus*. A, B = *Pionoconus easoni* Petuch and Berschauer, new species. Holotype, length 30.0 mm, NMNH IM-2000-33809. Taioha'e Bay, Nuku Hiva Island, Marquesas Islands. C, D = *Pionoconus easoni* Petuch and Berschauer, new species, length 29.1 mm, Taioha'e Bay, Nuku Hiva Island, Marquesas Islands. Specimen from the Berschauer collection. E, F = *Pionoconus catus* (Hwass, 1792), length 34 mm, Taioha'e Bay, Nuku Hiva Island, Marquesas Islands. Specimen in the Petuch collection; for comparison with the sympatric *Pionoconus easoni*. G, H = *Poremskiconus tourosensis* Petuch and Berschauer, new species. Holotype, length 16.7 mm, MZSP 135606. 10-15 m depth off Touros, Rio Grande do Norte State, Brazil.

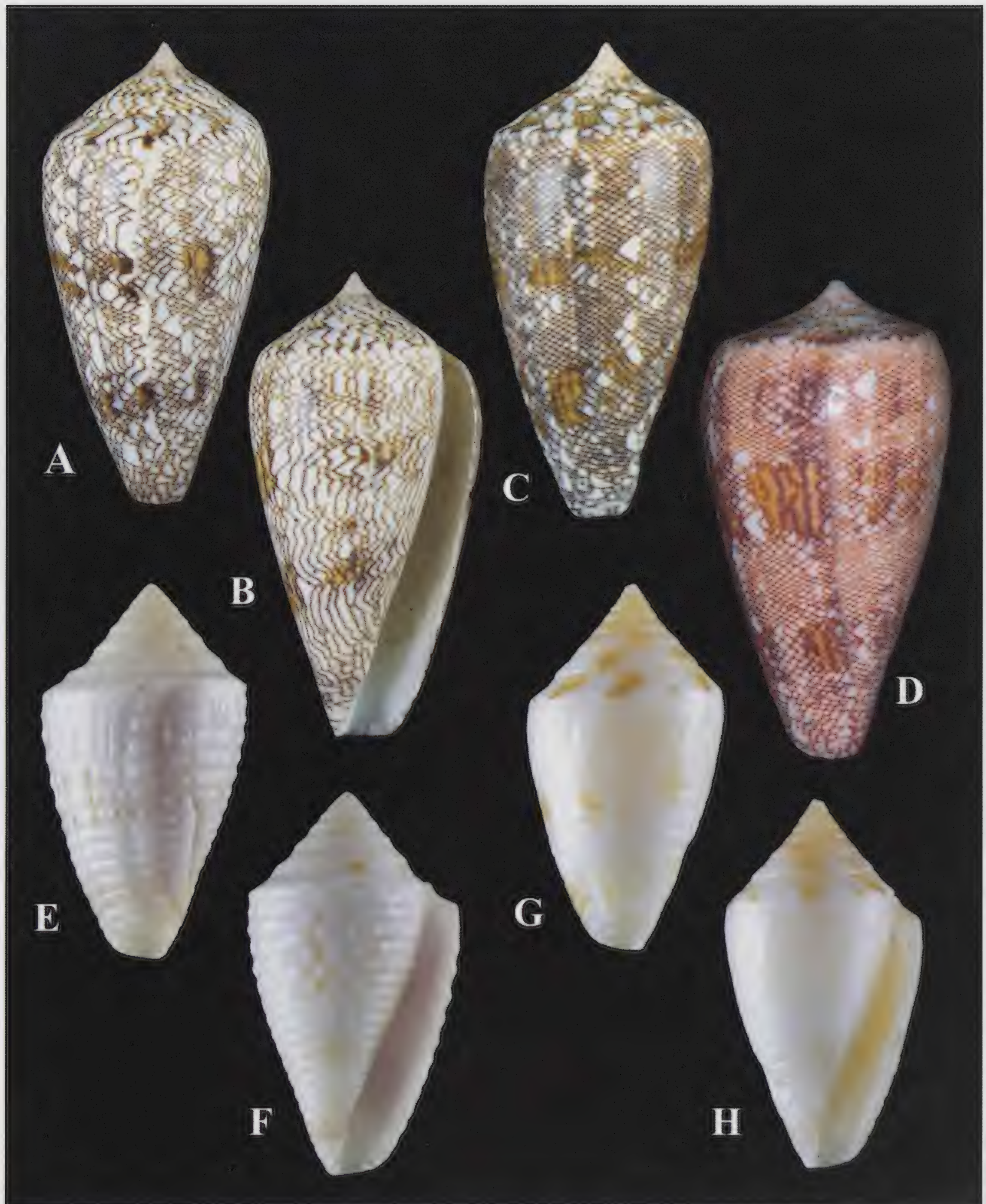


Figure 12. New Species of *Cylinder* and *Jaspidiconus*. A, B = *Cylinder abbas johnabbasi* Petuch and Berschauer, new subspecies. Holotype, length 55.0 mm, LACM 3499. Pangandaran, Java, Indonesia. C = *Cylinder abbas abbas* (Hwass, 1792), length 42.1 mm, Trincomalee, Sri Lanka. Specimen from the Berschauer collection, for comparison with *Cylinder abbas johnabbasi*. D = *Cylinder abbas abbas* (Hwass, 1792), neotype, length 60.5 mm. Trincomalee, Sri Lanka is here designated as the type locality of *Cylinder abbas* (Hwass, 1792). E, F = *Jaspidiconus crabosi* Petuch and Berschauer, new species. Holotype, length 20.6 mm, MZSP 135600. Ilha Boipeba, Bahia State, Brazil. G, H = *Jaspidiconus icapui* Petuch and Berschauer, new species. Holotype, length 15.1 mm, MZSP 135601. 30-40 m depth off Icapui, Ceara State, Brazil.

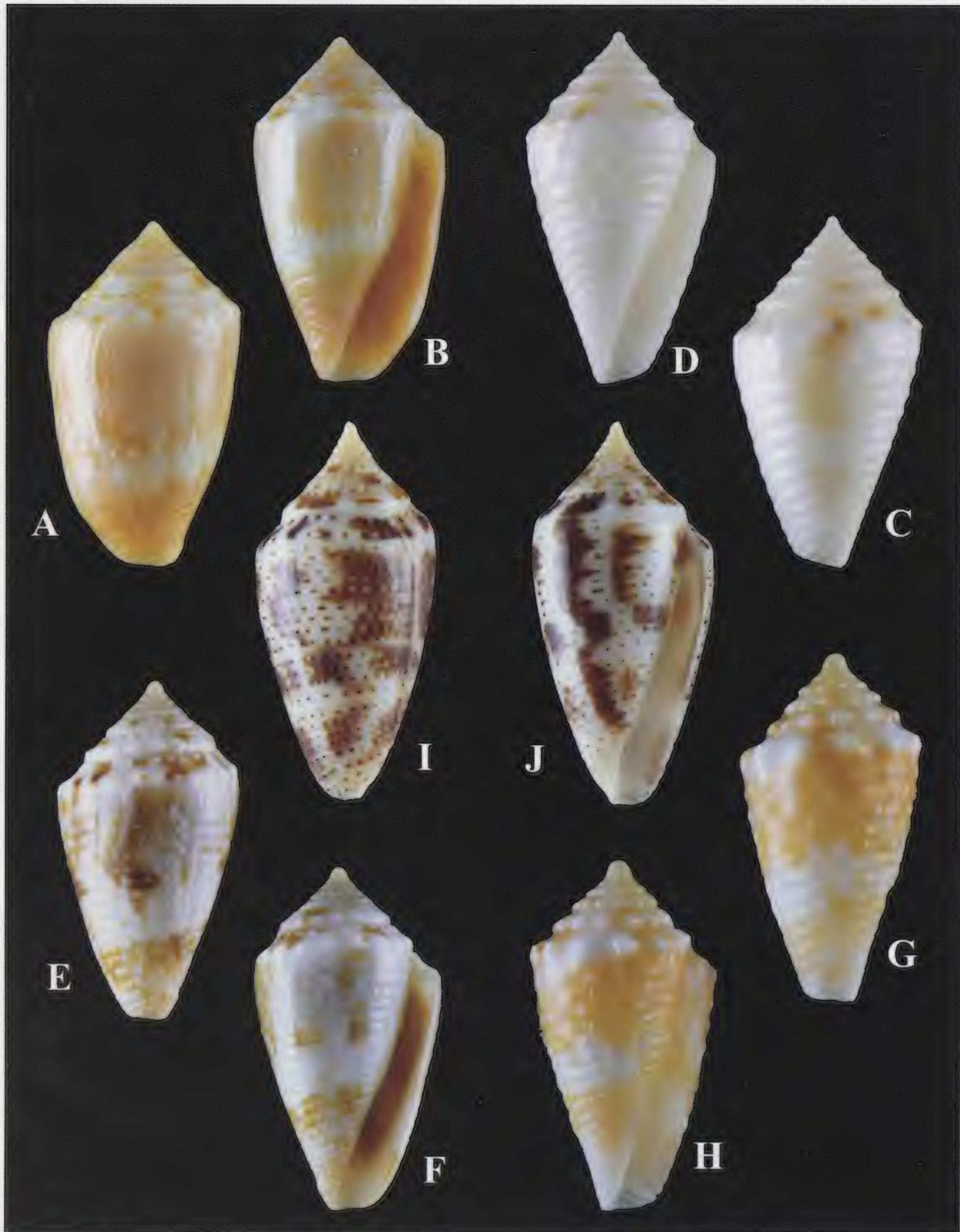


Figure 13. New Species of *Jaspidiconus* and *Coltroconus*. A, B = *Jaspidiconus itapua* Petuch and Berschauer, new species. Holotype, length 14.4 mm, MZSP 135602. Farol de Itapua, Bahia State, Brazil. C, D = *Jaspidiconus joanae* Petuch and Berschauer, new species. Holotype, length 16.5 mm, MZSP 135603. Rio do Fogo, Rio Grande do Norte State, Brazil. E, F = *Jaspidiconus keppensi* Petuch and Berschauer, new species. Holotype, length 14.9 mm, MZSP 135604. Alcobaca, Bahia State, Brazil. G, H = *Coltroconus bianchii* Petuch and Berschauer, new species. Holotype, length 11.2 mm, MZSP 135605. 120 m depth on Minerva Seamount, Bahia State, Brazil. I, J = *Ximeniconus gubernatrix* Petuch and Berschauer, new species. Holotype, length 22.3 mm, LACM 3500. On sand flats at low tide, south coast of Gobernadora Island, Gulf of Montijo, Veraguas Province, Panama.

The Recent Cypraeidae of Northern New Zealand from the Kermadec Islands to the Poor Knights Islands, Southwest Pacific Ocean (Mollusca: Gastropoda: Cypraeidae)

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ABSTRACT For researchers, isolated regions at the periphery of species’ distributions hold a peculiar fascination. The causes of their remoteness vary based on: distance (*e.g.* the Tropical Eastern Pacific), distance and countervailing currents (*e.g.* the Marquesas), location in a present day gyre (*e.g.* the Pitcairn Group) or the absence of present day means of veliger transport (*e.g.* the Vema Seamount). (Daughenbaugh & Beals 2013; Daughenbaugh 2015a & b, 2017). The northern New Zealand Region from the Kermadec Islands (Kermadecs) to the coastal and shelf areas in the northernmost part of New Zealand’s North Island (Northland), including the Poor Knights Islands (PKI), constitute the distributional boundaries for a number of Cypraeidae species. The boundaries are the result of the absence of coastal shelves along the east side of the Kermadec Ridge (Ridge) and precipitous drops to abyssal depths along Northland’s east coast continental shelf. Tropical waters, with their potential to transport Cypraeidae larvae, flow eastward from southern Queensland, Australia, entrained in the Tasman Front which terminates when reaching North Cape, the northernmost tip of Northland. There, the North Cape Eddy captures most of this flow while the remainder, the East Auckland Current (EAUC), flows intermittently southward along the eastern coastal, shelf and offshore areas of Northland into waters incapable of supporting Cypraeidae populations.

KEY WORDS Bay of Islands, Bay of Plenty, Cavalli Islands, East Australian Current, East Auckland Current, East Cape Eddy, *Erosaria cernica cernica*, *Erosaria cernica kermadecensis*, *Erosaria cernica tomlini*, Kermadec Islands, New Zealand, Northland, Poor Knights Islands, Raoul Island, Tasman Front.

INTRODUCTION While Cypraeidae species have been reported from the Kermadecs, Northland and PKI, the numbers are small. As with other end of range regions, this raises questions of the origin, timing and means of invasions, endemism and, in this region, possible connectivity between the Kermadec populations and Northland/PKI populations. The validity of *Erosaria cernica kermadecensis* (Powell 1958), currently considered a synonym of the nominate species, *Erosaria cernica cernica* (Sowerby III 1870), is also assessed. While the isolation of the population and an

examination of a limited number of specimens suggest the validity of the subspecies, an examination of additional specimens is needed to confirm their taxonomic features and their relationship to other populations.

Published and Other Reports of Northern New Zealand Cypraeidae Species

Published Kermadecs Reports

The largely uninhabited Kermadecs represent an imposing challenge to any prospective collector

due to their distance from mainland New Zealand (NZ) as well as any other land mass, and the consequent lack of support facilities. In 1990, the NZ Government placed the Kermadecs within a marine reserve, extending 12 nautical miles out to the territorial limits, further restricting access.

Nevertheless, several major expeditions have resulted in the identification of 302 gastropod species in the coastal marine faunas, intertidal to < 50 m, at the Kermadecs. However, virtually all collecting activity has been restricted to the northern Kermadecs where there are a number of anchorages and onshore locations at or near Raoul Island (Raoul) available for extended expeditions. There are a limited number of easily accessed intertidal sites at Raoul as well as more gradually inclined rocky slopes and rock walls on large boulders to about 20-30 m at Raoul as well as Chanter and Meyer Islands, northeast of Raoul. The southern Kermadecs are not included in the reports. Their molluscan fauna has not been comprehensively studied and is, therefore, poorly known. (Brook 1998a).

The first reports of Cypraeidae species at the Kermadecs were published in 1915 by W. R. B. Oliver based on collections made in 1908-10, which included 261 gastropod taxa. Five Cypraeidae species were documented, all from the northernmost island, Raoul, with three of the five records coming from beach collected specimens. The two live taken species were collected intertidally among rocks. The species collected were:

1. *Erosaria cernica cernica* (Sowerby III 1870)
2. *Erosaria poraria* (Linnaeus 1758) – live collected
3. *Luria isabella isabella* (Linnaeus 1758)
4. *Lyncina vitellus* (Linnaeus 1758)

5. *Monetaria caputserpentis caputserpentis* (Linnaeus 1758) – live collected.

Iredale (1939) recorded an *E. c. cernica* specimen from the Kermadecs. Subsequently, based on a specimen dredged off Raoul in March, 1952 between 58-85 m by the Danish Research Vessel, *Galathea*, Powell described *Ravitriona tomlini kermadecensis* (1958), subsequently referred to as *E. c. kermadecensis* (Powell 1958). This will be discussed further below.

These and subsequent reports were confirmed and summarized by Brook (1998a). The number of reported gastropod species was raised to 302, many of which are undescribed. Three additional Cypraeidae species were included, all dead collected, bringing the total number of reported species there to eight. The species collected were:

1. *Monetaria moneta* (Linnaeus 1758) – intertidally
2. *Talparia talpa* (Linnaeus 1758) – 10-30 meters
3. *Talostolida teres teres* (Gmelin 1791) – 20-30 meters.

In addition, fossil *E. c. cernica* were collected at Napier and Dayrell Islands, northeast and east northeast of Raoul respectively, from uplifted Early Pleistocene deposits from inferred mid-shelf depths. (Brook 1998a & b).

There have been no further published reports of additional Cypraeidae species at the Kermadecs. (Duffy & Ahyong 2015).

NOTE: The validity of the genus *Erosaria* is unclear at present. Meyer (2004) reclassified *Naria irrorata* (Gray 1828) as *E. irrorata*, although it formed a poorly supported sister clade to a strongly supported clade that included *E. albuginosa* and *E. poraria*. Some authors

have treated *Erosaria* as a synonym of *Naria* as the latter was introduced 26 years prior to *Erosaria*. As the generic status remains to be resolved, in the interest of continuity of the literature, *Erosaria* is here retained for all species presently classified in that genus. This is in accordance with the World Register of Marine Species (WoRMS) (Moretzsohn 2013).

Other Kermadec Reports

Over a number of decades, Allen Howell, a retired New Zealand crayfish fisherman, has undertaken annual months-long voyages around the Southwest Pacific. Sailing and diving from his yacht, he would stop at a number of islands and island chains, including Raoul. He probably has more experience observing Raoul marine fauna than any other person. He considers *E. c. cernica* to be moderately common there.

In total, about 200 specimens have been collected off Raoul by scientists and recreational divers, most in 15-35 m of water, on or at the base of rock walls covered with sponges, bryozoans, algae and sparse corals. (K. Walton, pers. comm. 2017).

Caledonian Shells dealer, Vincent Crayssac, was able to obtain a number of *E. c. cernica* from the Kermadecs, some of which were subsequently sold to collectors worldwide. A 26.4 mm specimen was acquired from Crayssac and resides in the author's collection. An additional two specimens were made available to the author for this study.

Published Northland Coastal/PKI Reports

While the number of reported Cypraeidae species from the Kermadecs is few, even fewer are known from Northland Coastal Areas (CA)/PKI. In addition, PKI, from which most mainland records originated, was declared a

marine reserve in 1981, making collecting off limits to recreational divers. Both *E. cernica* and *L. vitellus*, the only species reliably known from Northland CA, are still reported from PKI every few years by divers, although few active shell collectors dive there regularly or in other northern regions. (K. Walton, pers. comm. 2017).

Several *M. c. caputserpentis* and *E. e. erosa* were found in Northland CA waters in association with a floating oil rig, built in Singapore and towed to Whangarei Heads (Powell 1976), just to the southwest of PKI. These were never established as naturalized components of the fauna.

Powell (1967) reported the presence of *L. vitellus* at Shag Bay, west coast of Tawhiti Rahi Island, PKI. A live specimen was taken at 90 feet, which he illustrated, and dead specimens were taken in the same area at 100 feet. Cernohorsky (1971) reported only that "several specimens have been taken by divers at a depth of 60-100 feet (20-33 m)" at PKI. Elaborating on Powell's report, Grange (1973) reported that "subsequent dives around the same depth produced three well-preserved specimens, the largest being 59.0 mm long". In addition, he reported that two very fresh dead specimens were found elsewhere on Northland's east coast in 15 feet of water. The first was found at Goat Island, Leigh, to the southwest of PKI. Goat Island became a marine reserve in 1977. The second was found near Tutukaka outside an octopus lair. Tutukaka, considered the gateway to PKI, is just west of those islands.

Powell (1958), in describing *E. c. kermadecensis*, did not mention the presence of *E. c. cernica* in Northland CA/PKI waters. Eagle (1993) reports that the first two *E. c. cernica* recorded from New Zealand were collected in 1964 by Bill Palmer, at 30 m at PKI.

Cernohorsky (1971) reports a single, small and slender specimen found in beach debris at Cape Maria van Dieman (CMVD), at the northwestern most point of Northland. He also reports records of specimens from PKI collected at 60-120 feet (20-30 m), ranging in length from 27-31 mm. Elaborating, Powell (1976) reported that the Cape Maria specimen was very well worn and collected in 1933. (Note: The author is not aware of any earlier reports of *E. c. cernica* from mainland NZ waters.) Powell also records a specimen from 23-25 fathoms (42-46 m) off Deep Water Cove, Maunganui Bay, on the east side of Northland's Bay of Islands. Lastly, Powell reports that "more than twenty living examples are known to have been found by skin divers at Poor Knights Islands".

Eagle (1993) reported and illustrated a live collected specimen of *Cribrarula cribraria* (Linnaeus 1758). The specimen was reportedly collected in December, 1993 by an itinerant diver and fishermen and given to Eagle on a nearby beach when he expressed interest. The "small *Cypraea*" was reported to have been collected "at dusk by scuba, in a situation where there is active, well aerated water" at Motutara Island at the entrance to Whangaruru Harbor. The island lies approximately 5 km north and 35 km west of PKI. However, this record is at best considered spurious and it is unlikely that *C. c. cribraria* has ever lived in Northland CA/PKI waters. (K. Walton, pers. comm. 2017).

Fossil records are sparse. "Cypraeids have a sporadic record from earliest Eocene ... to Recent in New Zealand. Their general rarity and low diversity suggest that New Zealand was never fully tropical." Beu & Raine (2009). Aside from *Paleocypraea eripnides* (Darragh 2002), *Bernaya chatamensis* (Cernohorsky 1971) and two other unnamed species from the Paleocene, only two *Notocypraea* species from the Miocene have been described based on

fossil specimens. They are *Notadusta clifdenensis* (Cernohorsky 1971) and *Notadusta trelissickensis* (Suter 1917). These became extinct due to the terminal Miocene impoverishment. (Beu & Raine 2009). There are also a number of unnamed fossil species dating to the Miocene or earlier. The author was unable to locate any record of fossil *L. vitellus*, *E. c. cernica* or any other extant Cypraeidae species from mainland New Zealand.

Other Northland/PKI Reports

A 64.5 mm specimen of *L. vitellus* collected by a diver at 20-30 m in 1986 off Opuia, Bay of Islands on the east coast of Northland, resides in the author's collection. Opuia is northwest of PKI. The Andrew Spurgeon collection includes a 31 mm specimen collected by Bill Palmer at 90 feet (27 m) on a rock face at PKI.

Two *E. c. cernica* specimens from mainland New Zealand reside in the author's collection. The first is a small, slender 22.7 mm specimen, trawled in 120 m in 1984 off the Cavalli Islands, approximately 30 km north of Kerikeri. The second is a fresh dead 27.1 mm specimen, collected by a diver at 25 m in 1975 at PKI ex. Peter Poortman collection. In addition, Andrew Spurgeon's collection contains a 33 mm fresh dead, crabbed specimen collected at 80-100 feet (24-33 m) at the edge of the sand off the northeast point of Aorangi Island, PKI in 1978.

The Museum of New Zealand Te Papa Tongarewa (Wellington) has nine specimens of *E. cernica* from the Poor Knights Islands in six lots (46 m, 1, M.119890; 24 m, 1, M.145008; 37 m, 1, M.018475; 24-77 m, 3, M.020262; 1, M.118110; 2, M.277040). In addition, there are at least four additional PKI, one Cavalli Island and one CMVD specimens in private collections in New Zealand. (K. Walton, pers. comm. 2017).

Geography

Zealandia

Historically, the offshore ridges and plateaus to the north northwest of New Zealand's North Island have been considered an amalgam of continental islands, fragments and slivers rather than a true continent (*see* Figure 1). However, that view has been evolving over recent decades as more and better mapping of the sea floor has provided an alternative view. The latter posits the continent of Zealandia which covers 4.9M km² and is 94% submerged. Its northwest corner is separated by a mere 25 km from Australia's Queensland coast by the 3,600 m deep Cato Trough. Encompassing the Lord Howe and Norfolk Ridges to the east, with the latter including both New Caledonia and Norfolk Island, Zealandia encompasses both the North and South Islands of New Zealand as well as large areas to the south and east of the South Island. Comprised of very thin, stretched continental crust, the region evidences related elevated bathymetry, diverse and silica rich rocks and a low velocity crustal structure. (Mortimer *et al.* 2017).

However, the Kermadecs fall outside Zealandia as the southwest trending crust of the latter turns southward into the northeast coast of Northland, rather than northward to encompass the Kermadecs.

Kermadecs

The Kermadecs are a relatively short chain (215 km) of volcanic islands and rocks (*see* Figure 2). They lie in the middle of a long, near linear oceanic ridge, forming a frontal island arc stretching approximately 1,815 km from the southern Tonga Group (Ata Island), south southwest approximately 800 km to the Kermadecs' Raoul Island, continuing south southwest and terminating approximately 640 km north northeast of New Zealand's North Island. The ridge, beginning as the Tonga Ridge and continuing as the Kermadec Ridge, evolved as the result of the subduction of the Pacific Plate in the east beneath the Australian Plate in the west. Beginning in the Eocene (56-33.9 mya), the subduction also produced the Kermadec Trench. The latter trench lies in the center, between the Tonga Trench to the north and the Hikurangi Trench off the northeast coast of New Zealand's North Island. Lying to the east of the Kermadecs, it is one of the deepest oceanic trenches with a maximum depth of approximately 10,000 m. Just to the west of the Kermadecs lies the 2,500-3,000 m deep Havre Trough which is bounded by the Kermadec Ridge on the east and the parallel Colville Ridge, 175-200 km to the west. The latter ridge is considered to have separated from the former, beginning in the Pliocene, as a backarc ridge and forms the eastern boundary of the South Fiji Basin. The basin, with depths ranging from approximately 2,700 to 7,000 m, combined with the Colville Ridge and Havre Trough, acts as a boundary between the Kermadecs and other South Pacific Islands to the west.



Figure 1. Northland Map.



Figure 2. Kermadec Islands and Ridge Map (NIWA: National Institute of Water and Atmospheric Research).

The Kermadecs first appeared as the emergent tops of a chain of largely submarine volcanic mountains from 1,000+ m depths along the crest of the Kermadec Ridge in the Pleistocene and have continued their emergence through to the Holocene (present day). (Brook 1998a & b). They lie in a south southwest trending line from 29.2° S 177.8° W to 31.3° S 178.8° W in three groups separated from each other along the top of the ridge crest. The Northern Group consists of Raoul and a number of small islands and rocks. The Central Group, 100 km south southwest of Raoul, consists of the northern Macauley Island and the adjacent Hazard Islet with Curtis and Cheeseman Islands 35 km to the south southwest, but still within the Central Group. A further 80 km to the south southwest lies the Southern Group consisting of L'Esperance Rock, a tiny rock pinnacle, and the submerged Havre Rock, representing the end of the Kermadecs' chain. The Central and Southern Group islands have very limited, if

any, shallow water (< 50 m depth) marine habitats due to the very small size of all but Macauley Island and inshore steeply inclined slopes along most of the coastlines. Further, the absence of suitable anchorage, except for large research vessels, at these islands has meant that almost all scientific expeditions have been conducted near Raoul.

The Northern Group, anchored by Raoul, is the largest and oldest group in the Kermadecs. Raoul represents the summit of a large submerged mountain mass approximately 35 km by 20 km aligned to the southwest, slightly inclined to the south southwest alignment of the Kermadec Ridge (*see* Figure 3). It is flanked off its northeast coast by a compact scattering of seven named islands, plus additional islets and rocks. The islands are Meyer, Napier, Nugent, Dayrell and the three Chanter islands. The seven islands in total cover a land area of approximately 0.51 km². Raoul itself is anvil shaped, with a huge caldera in the center which supports three lakes. Its six km north-south length and 10 km east-west length covers approximately 29.4 km². The island is still active volcanically with the most recent eruption having occurred in 2006.



Figure 3. Map of Raoul Island, in Kermadec Marine Reserve Map (Department of Conservation, *Te Papa Atawhai*, New Zealand Government).

Stratigraphic studies have centered on the southeast and east coast of Raoul as well as the seven flanking islands. Together they have been designated the Herald Group. The study of early volcanic and sedimentary sequences revealed poorly constrained (uncertain) age estimates within the group. However, the studies have posited a 1.4 ± 0.8 mya age for the oldest of the three formations studied. The second oldest was posited at 1.1 ± 0.1 mya age. This places the age of the group in the Early Pleistocene. Subsequently, the group has been subject to further eruptions, uplifting and subsidence and the accumulation of sedimentary surface substances. The study material consisted of submarine lava flows, coral patch reefs, algal limestone and molluscan fossils. These were posited to have accumulated at intertidal to mid shelf depths on the sides of volcanic islands which were subject to subsequent erosion. (Brook 1998a & b). An earlier study indicated that the Northern Group has existed continuously since at least the middle to late Pleistocene. (Lloyd & Nathan 1981).

Brook 1998a wrote:

"...there is a limited range of physical habitat types at intertidal and shallow subtidal depths around the northern Kermadec Islands, and all but a very few sites ... are exposed to unrefracted oceanic swell and storm waves. The smaller islands are encircled by rocky reefs, whereas boulder coasts and gravelly sand beaches predominate around Raoul Island. Steeply sloping rocky reefs, commonly with crevices, caves and overhangs, occur to between 10 m and 70 m depth around the smaller islands and rocks, and on parts of the southern and southeastern coasts of Raoul Island. More gently sloping substrata of in situ rock or large boulders are present locally around Meyer, Chanter and Raoul islands to depths of approximately 20-30 m. Volcaniclastic

gravel and sand substrata extend offshore from sandy and boulder coasts around Raoul Island, and fringing aprons of mixed ... gravelly and sandy sediments are present below approximately 10-20 m depth to seawards of rocky reefs around Raoul and the smaller islands.... Hermatypic scleractinian [Hard] corals are present at the Kermadec Islands, but there are no coral reefs or Bioherms. Hermatypic coral cover on rocky reefs around the northern Kermadec Islands is typically greatest at 1-6 m depth, constituting up to 40%. Below that, corals generally contribute less than 10% of benthic cover on reefs, but increase in abundance to approximately 15-25% cover between depths of 18 m and 25 m in some areas. Coral cover decreases to less than 1% below 25-30 m depth."

The Gap

The southern most of the Kermadecs Islands is L'Esperance Rock, while the undersea Ridge continues its south southwest trajectory approximately 200 km further as far as the Bay of Plenty on the east coast of Northland. Numerous submarine volcanoes line the Ridge throughout its entire length.

Northland/PKI

Northland lies over 100 km to the northwest of the Bay of Plenty where remnants of the Kermadec Ridge terminate (see Figure 1). The region is a narrow peninsula in the northernmost part of New Zealand's North Island. It stretches approximately 330 km northwest, 85 km at its widest and 7.5 km at its narrowest, from approximately 80 km north of Auckland to North Cape at the northern most tip of Northland. Underlain mostly by hard compressed sandstone (greywacke) formed on the seabed between 280 and 135 mya, the

region was shaped by uplifting greywacke and volcanic rock. Ancient volcanoes have formed many of the region's mountain ranges while more recent volcanic activity and erosion helped shape the coast and its near shore islands.

The Northland's 1,700 km coastline encompasses the west, north and east coasts. The relatively straight west coast is indented with several broad, shallow bays. The far north coast features three prominent capes and many smaller capes along a very short coastline, from west to east: Cape Maria van Dieman, Cape Reinga and North Cape. The more irregular east coast features rocky headlands, deep water harbors and sandy bays. One of the largest of these sandy bays, the Bay of Islands, is a drowned river valley with numerous tributaries, with resultant estuaries, small embayments and a sprinkling of 150 islands. The bay is at its deepest at its exposed entrance where depths range from 50-60 m. Prominent offshore island groups include the Cavalli Islands (eroded mainland remnants), the Hen and Chicken Islands and PKI. The latter two are volcanic remnants.

The Poor Knights Islands, lie 24 km off Northland's east coast and 50 km northeast of Whangarei at 35.28° S 174.44° E. PKI consist of two large islands and numerous small islets and stacks between and adjacent to the two islands (see Figure 4). Tawhiti Rahi, at 1.51² km, is the larger of the two while Aorangi, at 1.0² km, lies immediately to the south of the former. Located in the open ocean, PKI experience very strong wave attacks from all directions, but primarily from the north and northeast. These have resulted in high cliffs, continuing below the surface of the ocean, around the north end of Tawhiti Rahi and along the east coasts of both islands. Erosion caused by wave action along perimeter fractures has resulted in cuts, caves, arches and land slides with the base levels of the

majority of coastal and subsurface caves and arches carved out during the second to last glacial period. (Hayward 1991).



Figure 4. Poor Knights Islands Marine Reserve Map (Department of Conservation, *Te Papa Atawhai*, New Zealand Government).

Over a basement of greywacke, the PKI are composed of volcanic debris, probably on the western slopes of an active volcano. In the late Miocene, the present PKI were buried under about 500 m of this debris. Volcanic activity ceased approximately nine mya. Since then, extensive erosion, primarily during the last million years of the Pleistocene, has led to the present size and configuration of the islands. The PKI have probably not have had any connection to the mainland since approximately two mya. At present, the islands rise rapidly from 100-125 m from the floor of the outer continental shelf. (Hayward 1991).

“At the peak of the last glacial period about 23,000 years ago, the oceans were a different place. Sea level fell by about 120 m as water was retained within expanding polar ice caps. Most of the continental shelf – the submarine plain surrounding New Zealand – was exposed.... The entire coastal current system was forced 20-200 km offshore by the exposed shelf.” (Carter 2001). Cooler water temperatures and greatly reduced viable habitats makes it is doubtful that any Cypraeidae species were present in mainland NZ waters during the Otiran glacial cycle, 23-12 mya. While most present day local temperate species survived the transition, it is unlikely that any subtropical Cypraeidae species would have survived through the glacial period.

Subsequent to the peak of the last glacial period approximately 23 mya, sea levels began to rise as the planet gradually warmed. Northland’s continental shelf and offshore islands were once again submerged with ocean levels rising to their current level approximately 12 thousand years ago (“kya”). The Tasman Front gradually shifted south to its present day position approximately 10 kya. Winds were reduced, seas became less turbulent and currents slowed. (Carter 2001). In time, this produced the conditions which would result in subtropical waters being transported to the temperate waters of Northland’s east coastal areas and offshore islands, including PKI, via the Tasman Front and the EAUC.

Oceanic Currents

Northland CA/PKI

An understanding of the oceanic currents and conditions which impact Northland CA/PKI begins with an understanding of the East Australian Current (EAC), the tributary Tasman Front and the off shooting East Auckland

Current (EAUC). The EAC represents the western boundary current of the South Pacific Subtropical Gyre. It flows from the Coral Sea southward along the Queensland coast and onward to Sugarloaf Point (32.5° S), New South Wales, 275 km north northeast of Sydney. From there, part of the current separates from the coast and begins a north-south undulating flow eastward as the Tasman Front. (Tilburg *et al.* 2001).

The Tasman Front is the connection between the subtropical EAC western boundary current and the EAUC eastern boundary current off Northland’s eastern coast. The EAC, acting as a zonal jet across the Tasman Sea, captures subtropical water from the southern flowing waters of the Tasman Sea. It then flows eastward to Northland’s North Cape, undulating generally north and south in response to the ridges and troughs in its paths with anticyclonic eddies and meanders as an integral part of the front. The meanders are influenced by several subsurface ridge systems, *i.e.* the Dampier Ridge, Lord Howe Rise and Norfolk Ridge. Measurements have shown that the waters of the Tasman Front are shallower than those of the EAC which extends below 2,000 m. Rather, Tasman Front flows encompass the upper 800 m. In addition, Tasman Front flows are narrower than those of the EAC, coupled with the meanders and instances of anticyclonic flow reversal, constitutes a weaker connection between the EAC and the EAUC than that of a contiguous western boundary system. (Sutton & Bowen 2014).

The EAC/Tasman Front flows present the potential for the transport of Cypraeidae larvae from several locations from the west to the east coast of Northland CA/PKI. The closest potential sources are Lord Howe Island and New Caledonia/Norfolk Island. The former is just north of the Tasman Front which is fed

from currents from the north, making the transport of larvae into the front almost certain. The distance from Lord Howe to NZ's North Cape is approximately 1,340 km.

Owing to the complicated nature of the Tasman Front, it is not possible to calculate a reliable distance or transit time for larvae originating from Lord Howe Island. However, tracking of transit times for rock lobster larvae (*Sagmariasus verreauxi* H. Milne Edwards 1851), released from the east Australia coast just to the west of Lord Howe, resulted in a median transit time of 838 days. However, 3% of the drifters took less than a year (one larval life time) to cross to New Zealand. These larvae were entrained in the Tasman Front. (Chiswell 2014).

While that timeframe may work for long lived rock lobster larvae, it is unlikely to work for lesser numbers of Cypraeidae larvae originating from Lord Howe. While precise larvae life spans for *L. vitellus* and *E. c. cernica*, as well as other Cypraeidae species, are not known due to a variety of complicating factors, they are estimated to have only moderate life spans (Paulay & Meyer 2006). As a result, Lord Howe is an unlikely source of larvae.

NOTE: During times of La Niña, the EAC flows along the east coast of Australia extend farther south, allowing tropical species from Queensland to migrate into areas they are not normally found, *i.e.* New South Wales and eastern Victoria. Likewise, the Tasman Front extends further south. These extensions are reversed with the return of El Niño. The west to east flow rates of the EAC do not appear to be significantly impacted by either.

New Caledonia and Norfolk Island, which lies south of the former, lie approximately 1,270 km and 370 km north of the Tasman Front

respectively. The coastline at Norfolk is characterized by cliff faces, similar to Raoul and PKI, and is unlikely to host significant Cypraeidae populations. However, it does hold the potential to act as a source of migrants from local Cypraeidae populations or as a stepping stone for migrants from New Caledonia. Currents flow to the south into the Tasman Front from these islands, leaving approximately 550 km to reach the North Cape.

The author is not aware of any studies on currents flowing from New Caledonia/Norfolk Island to the Tasman Front. However, the route south does not possess the geological obstacles existing along the front to the west. South of the Norfolk Ridge, the front does begin a more direct flow toward the North Cape. For larvae reaching the front, the remaining 550 km would not likely pose a significant obstacle. As a result, the trajectory from New Caledonia/Norfolk Island is a more likely potential source of any immigrant veligers.

However, as the eastward subtropical flow of the Tasman Front approaches Northland's North Cape the majority of the flow enters the North Cape Eddy. The latter is a topographically constrained, anticyclonic eddy whose center lies approximately 150 km northeast of North Cape. As the eddy contracts, southernmost Tasman Front waters not captured in the eddy as well as water from the edge of the eddy form the intermittent EAUC. By its nature, the eddy prevents the formation of a continuous EAUC. The EAUC flows closest to the shore from the North Cape to 35°S, around the Bay of Plenty, where it begins to move over the shelf and farther offshore to the Bay of Plenty where it flows either joint the East Cape Eddy or the East Cape Current. The EAUC is normally stronger in the spring and summer (*see* Figure 5). (Stanton *et al.* 1997).

As noted, the nature of the North Cape Eddy precludes a continuous EAUC and can act as a limit or an obstacle to the transport of larvae to Northland CA and its offshore islands.

Northland CA/PKI Cypraeidae Origins

Two hypotheses which could account for the two Cypraeidae species extant in Northland/PKI waters are examined below. Neither has sufficient evidence to support a definitive conclusion. Genetic analysis, when it becomes available, would likely provide support for one of the two hypotheses.

Present Day Migration

Powell (1976) first hypothesized “Natural causes contributing to greatly increased influx of warm water molluscs and other invertebrates to our shores could be accounted for by a small increase in water temperature coupled with possible fluctuations in surface water currents, which would enable an increasing number of warm water species to colonize Northland waters. ... It would appear that some molluscs arriving here in their larval stage in massive strength manage to grow to adults but are unable to reproduce because of lower temperatures than their normal requirement”. Morley and Hayward (1999) echoed Powell’s comments, but added “three such [warm water] species that have been introduced to the Bay of Islands by warm currents, and that have bred for a season or two and established small populations, now appear to have died out”. The three species are *Perirhoe circumcincta* (Deshayes 1857), *Phenacovolva wakayamaensis* (Cate & Azuma 1973) and *Natica lemniscata* (Philippi 1852). However, two of those three species have been collected alive this year (2017) and the third, *P. circumcincta*, is only known from a small remote area that hasn’t been re-sampled since that initial survey in which

they were recorded. There is no evidence that it is not still extant there. (K. Walton, pers. comm., 2017).

Temporary, significant retractions of the North Cape Eddy, would allow the EAUC to facilitate temporary, greatly increased influxes of warm water into Northland CA to the Bay of Islands and the offshore island groups, including PKI. However, while these warm water influxes represent a possible hypothesis for the presence of *L. vitellus* and *E. c. cernica* at the Bay of Islands and PKI, it does not provide support for:

1. The presence of *L. vitellus* in coastal areas south of the Bay of Islands, nor does it
2. Explain the presence of only two Cypraeidae species in these waters, despite the presence of many other Cypraeidae species in areas to the west and northwest, particularly New Caledonia and Norfolk Island, nor does it
3. Explain the presence of these two particular species, nor does it
4. Explain the wide variation in the shell features of *E. c. cernica* found at PKI, (K. Walton, pers. comm. 2017), potentially indicating possible larval dispersal from multiple source populations.

The continued presence of these two Cypraeidae species as well as several other warm water species, suggests that these are ongoing, breeding populations rather than just present day migrants.

Pleistocene Invasion

An alternative hypothesis would consider them as relictual self sustaining populations from earlier invasions that may or may not be

supplemented by on-going sporadic migrant dispersal.

As sea water levels lowered during the ice ages, the habitat for shallow water specimens was severely reduced and, particularly in the Western and Central Pacific, populations became isolated and extinctions occurred in lagoon and other shallow water habitats. Current flows were also reduced during these glacial events, thereby reducing larval dispersal. Subsequent flooding as each glacial maximum receded, restored connectivity between many populations and resulted in the repopulation of these habitats. Despite these extremes, few marine species became extinct. Pelagic larval duration (PLD) was not a strong indicator of population dispersal and range in the Pleistocene. (Ludt & Rocha 2015).

Northland CA and offshore islands would not have been immune from these events. It is probable that, as sea levels rose to present day levels and the Tasman Front shifted to its southern position 12-10 kya, at least two Cypraeidae species from multiple populations invaded the area. This also marked the beginning of more stable, predictable oceanic currents, limiting the potential sources for further migration.

Subsequent variations in oceanic conditions, such as occurred during NZ's Little Ice Age (LIA: 1450-1850 CE), were much less extreme than during Pleistocene Ice Ages, but would have produced challenging conditions for any Cypraeidae populations. Studies "suggest both colder- and wetter-than-normal conditions were a pervasive component of the base climate state across New Zealand during the LIA, as were colder-than-normal Tasman Sea surface temperatures". (Lorrey *et al.* 2013). This period, coupled with the region's temperate ocean temperatures would have been a challenge for

any subtropical or tropical Cypraeidae populations and most of these populations would have gone extinct over time.

The Two Cypraeidae Survivors

Of the two surviving Cypraeidae species, *E. c. cernica* is the least surprising. This is a wide ranging Indo-Pacific species which "is one of the most widely distributed species among cowries. The species is often found in deeper waters throughout the IWP and is found at shallower depths only in subtropical areas where water temperature is lower". (Meyer 2004). It has been trawled in deep water, 120 m, just north of the Bay of Islands and over 20 specimens have been reported from PKI, at depths similar to and deeper than at Raoul. This suggests that there may be populations extant in deeper water offshore Northland CA north of PKI. It is likely that larvae from such populations would occasionally flow south to shallower waters at PKI as the intermittent flows of the EAUC permitted.

While *L. vitellus* is not considered a deep water Cypraeidae as is *E. c. cernica*, it has adapted to such depths (*see* Plate 3). The author personally collected a specimen at 34 m off the wreck of the *Augustina* in the Java Sea and acquired a specimen trapped at 80-100 m from a fishing boat in Wanli Harbor, northern Taiwan. It is also one of the most wide ranging and hardiest species. *Lyncina vitellus* was collected at 20-30 m off the Bay of Islands and in coastal areas south of there as shallow as 4.5 m. Specimens were collected at PKI from 20-33m. As with *E. c. cernica*, the presence of *L. vitellus* at PKI is likely the result of flows from the north. The presence of *L. vitellus* in shallower waters in coastal areas just west of PKI could represent either larvae carried by expanded, eastward EAUC flows from the north or relictual

populations extant in areas not often frequented by shell collectors.

Both Cypraeidae species, as well as others with low diversity clades, share certain characteristics: “(1) They have large geographical ranges with little population structure, indicating good dispersal ability. (2) They exhibit morphological stasis based on fossil first occurrences. (3) They have never experienced pulses of diversification, but instead appear to hover just above the perilous extinction boundary for their duration. ... and if they have more than one species, additional ones are all peripheral endemics”. (Meyer 2003). Their survival would not be unexpected.

Kermadecs

The Kermadecs, including Raoul, occupy a peripheral region which is isolated in the approximate middle of the South Pacific Subtropical Gyre, unconnected with any other subtropical or tropical region by present day predictable regional or boundary currents (see Figure 5).

However, a study of the connectivity between the Kermadecs and the mainland was made based on simulations of larval transport using virtually generated larvae seeded in the Kermadecs and Northland's east coast and the Bay of Plenty. Virtual larvae were seeded at five locations in the Kermadecs and 12 locations along the northeast coast of New Zealand. One hundred larvae were seeded at each location every 25 days between January, 1993 and November, 2007. (Sutton *et al.* 2012).

The results showed that the mean surface currents in the region are weak and dominated by eddies. Larvae spread over a wide area with a slight eastward bias. Within the Kermadecs, possible transport to the other islands was in the

order of 3-10 days. Exchange from the Kermadecs to Northland would take 50 days from Raoul and 20 days from L'Esperance Rock. However, the study showed that larvae from the Kermadecs were transported well offshore to the east of the uppermost part of Northland, *i.e.* north of 35° S where the Bay of Islands is situated. No larvae reached Northland CA or the Northland shelf. (Sutton *et al.* 2012).

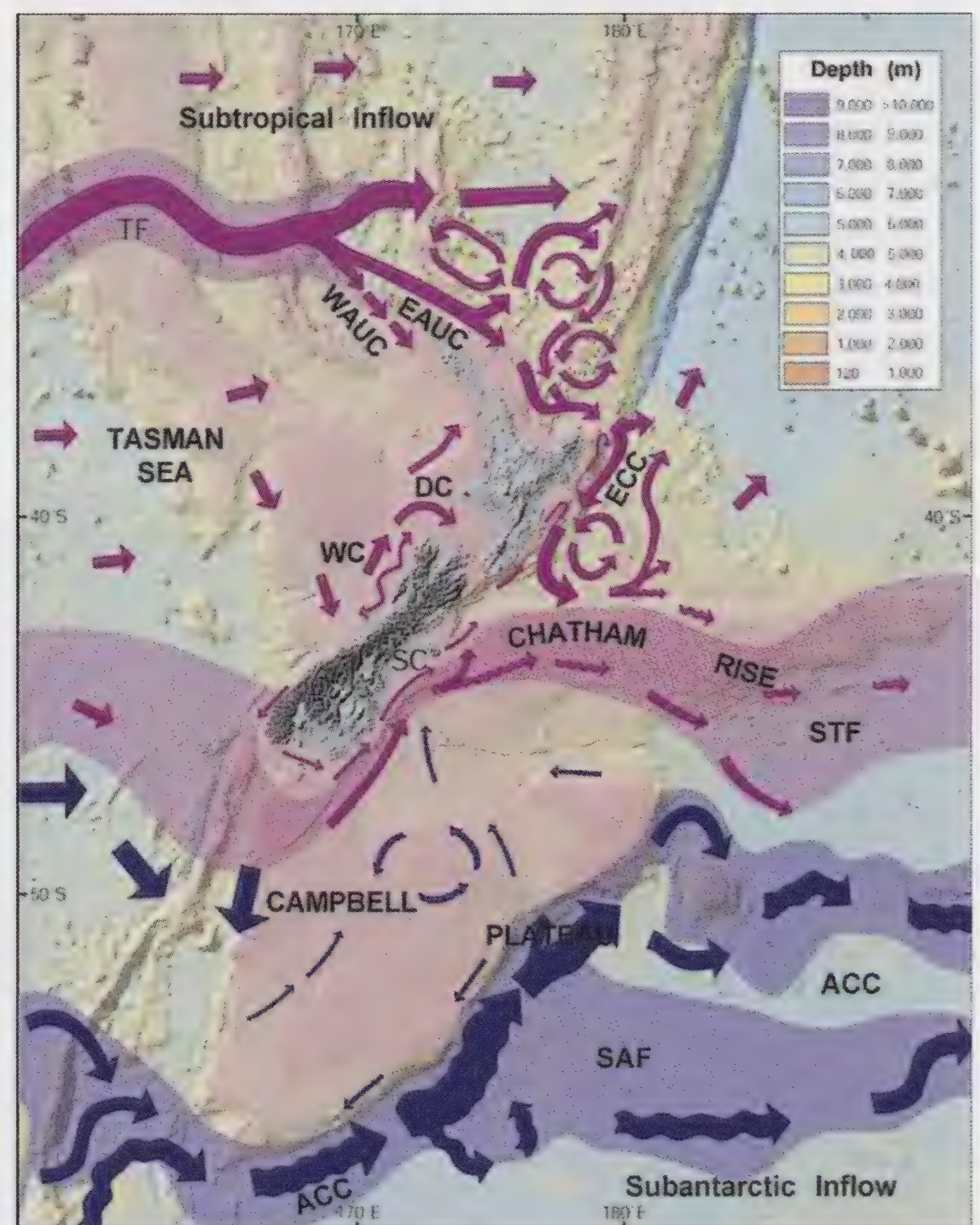


Figure 5. Ocean Currents Map. Craig Stevens and Stephen Chiswell, 'Ocean currents and tides - Currents', Te Ara - the Encyclopedia of New Zealand, <http://www.TeAra.govt.nz/en/map/5912/ocean-currents-around-new-zealand> (accessed 22 January 2018)

Most of the larvae released from the mainland were largely contained within the EAUC and trended southward along the continental shelf. The remaining larvae scattered northeast over a wide arc with some larvae reaching the Kermadecs after 30 days. Even allowing for longer larval life cycles, the study concluded

there is limited connectivity between mainland New Zealand and the Kermadecs. (Sutton *et al.* 2012).

Kermadec/Raoul Cypraeidae

Remote from any border currents, the origin of the molluscan species at Raoul is not definitely known. Rather, hypothetical affinity areas have been posited where Kermadec species are also found. These range from areas to the west (eastern Australia, Elizabeth and Middleton reefs, Lord Howe Island, and Norfolk Island), New Zealand and the Central and Eastern Pacific, including Pitcairn and Easter Island. (Brook 1998a). However, no support has been offered for any of these areas.

All eight Cypraeidae species reported from Raoul are among the widest ranging and most prolific of all species. They range from the East African coast, across the Indian Ocean to Australia, across the Pacific Ocean, some as far as Hawaii, French Polynesia and the TEP. They have also adapted to a variety of habitats. Studies of such wide ranging species at periphery regions have resulted in the central marginal hypothesis, a.k.a. the core periphery hypothesis. These hypotheses posit that end of range populations exhibit “low genetic diversity and high genetic differentiation relative to populations within the core of a species range.... These genetic patterns ... are a consequence of reduced population size and



Plate 1, Figures 1-2. *Erosaria cernica*: **1a-d** *E. cernica*, Dumbea Pass, Noumea, New Caledonia, diver at 20-30 m. 31.9 mm. SBMHN 163933 **2 a-d** *E. cernica*, Raoul Island, Kermadec Islands, diver at 25 m, 26.4 mm. SBMNH 163934. Both ex- Vincent Crayssac. Compare the collumellar dentition of **1a** with **2a**, illustrating the features described by Powell for **(1)** *E. c. tomlini* from New Caledonia vs. **(2)** *E. c. kermadecensis* from Raoul. Also, note the more numerous columellar and labral teeth of **(1)**. It should be noted that the New Caledonia specimen represents only one population of *E. cernica* among a number of other New Caledonian (and its surrounds) populations with significantly different features.

connectivity toward a species range periphery.” While no such studies have been performed on Kermadec Cypraeidae, a study was conducted on two wide ranging species found in the Kermadecs. These are the Crown of Thorns star fish, *Acanthaster planci* (Linnaeus 1758) and the sea urchin *Tripneustes gratilla* (Linnaeus 1758). “The haplotypic composition of both populations suggests they have been founded by a small number of colonists with little subsequent immigration. Thus, local reproduction and self-recruitment appear to maintain these populations despite the ecologically marginal conditions of the Kermadec Islands for these tropical species.” (Liggins *et al.* 2014).

While this study is narrow in scope and subject to subsequent revision, the Cypraeidae at Raoul are in the same region and subject to the same oceanic and habitat conditions as the Crown of Thorns and urchins in the Kermadecs. Self recruitment is probably relatively high and the majority of Cypraeidae veligers produced at Raoul are probably retained locally. Similar invasions have occurred in the Marquesas where genetic studies have shown that six endemic Cypraeidae species were the result of Pleistocene invasions approximately 1.58 million years ago (“mya”) (Daughenbaugh 2015a). As above, flooding subsequent to glacial maximums resulted in the spread of molluscan populations. This suggests that the Raoul Cypraeidae populations are possibly, if not probably, the result of such Pleistocene invasions. The finding of *E. c. cernica* fossils in Early Pleistocene deposits in the Raoul’s Herald Group is supportive.

Erosaria cernica kermadecensis

A fossil history that dates to the Early Pleistocene and the collection of a significant number of specimens in recent times supports the status of *E. c. cernica* as an extant

population at Raoul. Has time and isolation allowed the Raoul population to evolve into a distinct subspecies? Powell, in 1958, named the population *Ravitrona tomlini kermadecensis*, about a decade ago reclassified as *Erosaria cernica kermadecensis* (Powell 1958) and today placed into synonymy with *E. c. cernica* by most authors.

The Holotype was trawled at 58-60 m off Raoul on March 3, 1952. Powell’s description reads “Shell shining but not highly polished. Dorsum dull orange marked with evenly distributed but irregularly sized white spots. Sides, base, teeth and interior porcellaneous white. Margins coarsely pitted, a few dark reddish-brown spots in the anterior and posterior series of pits and others sparsely and irregularly distributed along the sides, more numerous along the labial side. Labial teeth 19, Columellar teeth, 18, exclusive of the anterior and posterior ridges and two strong denticles on the fossula.” The length of the Holotype is 24 mm, width 15 mm and height 11.75 mm.

In his discussion, Powell stated that the Kermadec population should be regarded as a subspecies of *Erosaria tomlini* (Iredale 1939), choosing Iredale’s treatment of the New Caledonia population over *E. c. tomlini* (Schilder 1930). The latter included all southern Melanesian populations. He also compared the Kermadec shell to *Ravitrona [Erosaria] tomlini prodiga* (Allan 1956), type locality Newcastle, New South Wales. Allan (1956) also included Queensland, Lord Howe Island, Norfolk Island, and the Kermadecs in the distribution, excluding New Caledonia, presumably retaining it in Schilder’s southern Melanesian population.

Powell’s separation of the Kermadec population was based upon differences in the columellar teeth of the three populations. He separated *E. c. kermadecensis* from the “*E. tomlini prodiga*” populations stating the latter’s “teeth are short

and evenly graded throughout". Tarrant, in his comprehensive book on the Cowries of New South Wales, contains a plate of specimens from NSW which supports this aspect of Powell's assessment.

The columellar dentition differences between the New Caledonia population and the Kermadec population are more nuanced (*see* Plate 1). Powell noted that New Caledonian shells "are long at the posterior end but short over the anterior end, not graded but suddenly stepped just posterior to the middle. ... The Kermadec subspecies has evenly graded teeth also but they are long, extending medially almost a third of the way across the basal callus." The Holotype was figured at the end of the article and it accurately reflects Powell's description.

Various authors have proposed at least eight subspecies and to date, all but two have been placed into synonymy (*see* Plate 2). The species exhibits very variable shape, callosity, color and dentition features within most regional populations. This is true of both *E. c. prodiga* and *E. c. tomlini*. The latter's dentition in particular includes specimens aligning with Powell's comparative description. As such, both populations are appropriately considered *E. c. cernica*, the nominate species.

The one subspecies relevant to this study which has been generally accepted is *Erosaria cernica leforti* (Senders & P. Martin 1987) from remote, end of range Easter Island. There, the population has developed distinct, consistent features indicative of a self recruiting population. These include fusing anterior columellar teeth, dense postulate marginal spotting and excess callous along the margins and the ends of the shell. These features allow the subspecies to be easily recognized.

The three Raoul specimens on hand also exhibit distinct, consistent features indicative of a self recruiting population. These include the columellar teeth as described by Powell, an ovate, slightly inflated shape with rounded margins and a white spotted, orange dorsal coloration. While these features are more nuanced than *E. c. leforti*, the three specimens at hand all exhibit them. However, while it is likely that the Raoul population represents a valid subspecies, additional specimens are needed to garner the support necessary to propose removing it from synonymy. Genetic analysis, should it become available, would also shed light on the origin(s) and the timing of the population's invasion. As such, the population will remain classified as *E. c. cernica* for the purposes of this paper.

ACKNOWLEDGEMENTS

Kerry Walton, Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand, provided comments and photos. Also in New Zealand, Peter Poortman, the source of the *E. c. cernica* in the author's collection, provided introductions to other local collectors. Andrew Spurgeon provided photos of *E. c. cernica* and *L. vitellus* from PKI. Marty Beals made specimens from his collection available. Paul Tuskes photographed specimens and prepared the plates. My appreciation and thanks to all. Lastly, my thanks to Dr. Henry Chaney, Curator and Howard/Berry Chair of Malacology, Santa Barbara Museum of Natural History, for his review of the manuscript.

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Plate 3, Figures 16-17. *Lyncina vitellus*: **16.** PKI, on a rock face at 90', < 1996-1997, leg. W. Palmer, 31 mm. **17.** Off Opua, Bay of Islands, Northland, N. Z., diver at 20-30 m, 1986, 64.5 mm. SBMNH 163937.



Plate 2, Figures 3-15. *Erosaria cernica*: 3. Same as 2a-b, 26.4 mm. 4, 5. Kermadec Islands, scuba at 15-20 m, 26.9 & 24.7 mm respectively. Both ex- Vincent Crayssac. 6. Cavalli Islands, Northland, N.Z., trawled at 120 m, 1984, 22.7 mm. SBMHN 163935. 7. Poor Knights Islands (PKI), N. Z., diver at 25m, 1975, 27.1 mm. SBMHN 163936. 8. PKI, off the NE point of Aorangi Island, diver at 80-100', 1978, 33 mm. SBMHN 163937. 9. North side Noddy Island, off north coast, Lord Howe Island, SCUBA at 20 m, 1999, 22.1 mm. 10. Bellona Reefs, southern Coral Sea, west of New Caledonia, diver at 2-3 m on hard reef, 2001, 18.1 mm. 11. Sournois Reef, Boulari Passage, Noumea, New Caledonia, SCUBA at 3-5 m under coral rubble, 1987, 19.7 mm. 12. Ilot Maitre, Noumea, New Caledonia, diver at 20-25 m in algae on sand, 1978, 18.2 mm. 13. PKI, North Island, 37 m, 1975, leg. W. Palmer. M.018475*. 14. PKI, 1975, ex. JR Penniket, 32.5 mm. M.118110*. 15. PKI, North Island, Northern Arch, S side, 24 m, 1984, Dunning, JR. M.145008*.

*Accession numbers. Museum of New Zealand, Te Papa Tongarewa, Wellington, New Zealand.



Have a shell collection you would like to donate to The San Diego Shell Club?

The San Diego Shell Club is interested in your shell collection. As a 501c(3) organization, all donations to our Club may provide a tax write-off. When we receive a donation we provide a letter describing the items that may be used when filing your taxes. While we cannot provide a value, donations of up to \$5,000 do not require a written appraisal. Since tax laws change regularly we recommend that you check with your tax accountant before relying on any information provided here.

We are interested in all types of shells, marine or land and all genera and species, books on shells as well as items related to shells such as artwork, storage cases and tools. Your items will be used to generate income to support the Club's efforts in continuing Public education about shells and conservation of marine life throughout the world. If you would like to donate, please contact David Waller, SDSC Acquisition Chairperson, at dwaller@dbwipmg.com to schedule a time to discuss charitable gifting.

CLUB NEWS

2017 November General Meeting, Elections and Auction

The November meeting was held on November 18, 2017 at David and Felicia Berschauer's home in Laguna Hills. Following the general elections there was food, beverages, and the auction of shells from the Pratt Collection. For more information about the auction see the article on page 64.

2017 December - Holiday Party

Our holiday party was held on December 9, 2017 at David and Viviane Waller's home in Encinitas. See article on page 66 for further information.

2018 January General Meeting

Our January meeting was held on January 20, 2018, at David and Viviane Waller's home, with a presentation by David Waller titled "Memoirs of a Collector." There was food, beverages, and shells to be had by all. Special thanks to David and Viviane Waller for hosting and for letting the Club utilize their home for this meeting.

President's Message

Dear Members,

I am pleased and honored to be elected your President for 2018 and would like to thank you for your support. This is going to be an exciting year for the San Diego Shell Club. Along with our normally scheduled events, the April and November Auctions, our San Diego County Fair display, our September and Holiday Parties and the West Coast Shell Show, we will be hosting the 2018 Conchologists of America Convention.

This means that we have lots of work to do to prepare for all of these events. To help with all of the preparation we have filled three new Member-at-Large positions on the Board. In this regard, I would like to thank Lisa Lindahl, Bill Schramm and Rick Negus for stepping up to help as our new Members-at-Large. I would also like to congratulate the other elected members of the 2018 Board of Directors, David Berschauer, Leo Kempczenski, Duffy Daughenbaugh and Jill Spofford on their election.



As we start this New Year, I will be focusing my efforts in three key areas; membership, resources and attendance. First and foremost will be increasing membership. In 2014, our membership was about 50 and declining. With the hard work of our past two Presidents, Larry Buck and David Berschauer, we have increased our membership to over 190; a record high membership for our Club. My continued effort will require reaching out to shell collectors throughout the United States and overseas promoting our Club. I have already begun collecting e-mail addresses from around world with the hopes of having them celebrate with us The Festivus' 50th Volume Publication. It will be my goal to increase our membership to over 250 during this term.

The second area that I would like to focus on is restoring our Club's financial reserves to 2.5 times our annual budget. Having our reserves at this level will assure our success in times when our income generating efforts are unable to generate the level expected. Some of this will come from increased membership. The remainder will have to come from increasing our auction proceeds in April and November. This effort started in 2017 with the purchase of the Pratt Collection and a rare *Cypraea* collection that were brought to our attention by long time members Marty Beals and Julian Lee. I hope to continue these types of acquisitions in 2018. It is also important to note that while large volumes of shells come from these types of acquisitions, it is also the generosity of our members who donate shells on a regular basis that help keep our Club financially secure. I want to extend a sincere note of "thanks" to all of you who have donated in the past and to those who will donate in the future.

The third area in which I would like to focus my efforts is to identify how to inspire our local members to attend monthly meetings. I am not the first nor will I be the last President with a desire to increase attendance at meetings. It has been an issue addressed by both Larry Buck and David Berschauer. To their credit they have rotated our meeting locations to accommodate members living in San Diego as well as in Orange and Los Angeles Counties, they have increased the number of shells and other Club items for sale at our meetings, they have often provided food and refreshments as well as providing stimulating presentations. Improving attendance at regular Club meetings is a priority which will require some creative thinking, and I will do my best to achieve this elusive goal.

As you can see this will be an action packed year and I am hoping that every member will consider how they might be able to contribute to this history making twelve months. I wish all of our members a safe and prosperous New Year.

David B. Waller



Order your San Diego Shell Club collectible mugs in our new design for 2018 - while supplies last. \$15 each, plus 8% sales tax and shipping at actual costs. These 11 ounce mugs are great for coffee, tea or hot cocoa anytime. We accept PayPal for your convenience. See www.sandiegoshellclub.com

Jaspidiconus acutimarginatus is part of the Florida cone shell fauna

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INTRODUCTION

In 1866 G.B. Sowerby, II described a new Conidae species from a specimen that was sent to him by Mrs. Tombe Taylor as *Conus acutimarginatus*. This specimen was presumed to be from the Key West Florida area. This locality was later discounted as incorrect by Danker L.N. Vink in 1990, and a new type locality was subsequently designated as “Islas Chimanas, Estado Anzoategui, Venezuela.” (see Conus Biodiversity website). The discovery of specimens from Bocha Chica, Florida by the author, as well as specimens from the collections of Pascal Wink, Paul Kersten, Bill Fenzan and Edward J. Petuch (Rare and Unusual Shells of the Florida Keys, by Petuch and Sargent, 2011, at p. 166) all with Florida locality data have proven that the redesignation of the type locality by Vink to be incorrect.

DISCUSSION

Jaspidiconus acutimarginatus (Sowerby, 1866) apparently has a range that is restricted to the Middle and Lower Florida Keys where it is found in shallow water and prefers to live on fine carbonate sand near turtle grass beds (*Thalassia testudinum*) as both of the specimens that I personally collected were found in such an area. Interestingly, I also collected three specimens of *J. pealii*, two normal colored and one yellow colored one on the same field outing, however, they were along the edge of and in the turtle grass instead of being well into the sandy areas.

In June of 1983 my mother came to visit my wife Susan and I while we were in Key West, Florida after the passing of my father. My mother wanted to go to the beach, but not a public beach. We took her to my favorite secluded beach on the Atlantic side of Boca Chica Key near the end of the runways so she that she could get a good sun tan. While my mother was doing so, I went snorkeling, and that was the day I found the shells that I mentioned previously. Keep in mind that this was pre-internet days so shell identification wasn't as easy as it is today. Good shell books cost a lot more money than I could afford at the time and most of the public libraries didn't have many books that were useful for shell identification either.

At that time most of the small cones that were found in the Florida Keys were merely lumped together as *J. jaspideus* according to the R. Tucker Abbott in the books I had, so that's what they were all labeled. I put these small cones into my collection and gave no further thought to them.

Flash forward over thirty years to the internet era where information is now available with a few mouse clicks or the tap of a few keys on the computer. One day as I'm surfing the internet I saw a photo of the little cone shell that I had previously labeled as *J. jaspideus*, except they were called *J. pealii* so I dug thru my boxes and found all of my small cones from the Florida Keys. With this new found resource I was able to positively identify all of my small cones except for two.

Lucky for me when my new friend Ed (Edward J. Petuch) was riding with me in the truck we were able to bring with us three boxes of cones from my collection. When we found time to look through them Ed got excited when he saw the two small cones that I couldn't identify, so I knew that they had to be special. That's when Ed informed me that the small cones were *J. acutimarginatus*. The figures below are presented to show the variability of *J. acutimarginatus*.



Figure 1. *Jaspidiconus acutimarginatus* (Sowerby, 1866). **A** = Holotype 20.5mm, "Florida, Mrs. Tombe Taylor" in NHMUK; **B** = Little Duck Key, Florida, 20 mm (Pascal Wink); **C** = Little Duck Key, Florida, 19.4 mm (Bill Fenzan); **D** = Boca Chica Key, Florida, 17.4 mm (Eason); **E** = Boca Chica Key, Florida, 14.7 mm (Eason); **F** = Islamadora, Upper Maticumbe Key, Florida, 16 mm (Pascal Wink); **G** = old collection labeled as "Miami" Biscane Bay, Florida, 16 mm (Pascal Wink); **H** = Lower Matecumbe Key, Florida, 19.3 mm (Paul Kersten); **I** = Lower Matecumbe Key, Florida, 19.0 mm (Paul Kersten).

In 2015 David P. Berschauer illustrated a photo of the holotype of *J. acutimarginatus* as part of an iconography of the genus *Jaspidiconus*, and according to D.L.N. Vink it is from the Venezuelan Subprovince, coastal along Colombia to Venezuela. (Berschauer, 2015; Vink, 1990) While this is in line with the type locality redesignation by Vink ("Range: Probably restricted to the beaches of eastern Venezuela and nearby archipelago"), I feel that this locality for *J. acutimarginatus* is incorrect. Known reliable locality data for recent specimens of *J. acutimarginatus* are as follows:

Robert L. Eason, Sr.: Boca Chica Key, Florida Keys

Edward J. Petuch: Missouri Key, Florida Keys

Bill Fenzan: Little Duck Key, Florida Keys

Pascal Wink: Little Duck Key, and Islamadora, Upper Matecumbe Key, Florida Keys

Paul Kersten: Biscane Bay, Florida

The following small cone species were all collected on Missouri Key by E.J. Petuch (personal communication): *J. acutimarginatus*, *J. pealii*, *J. pfluegeri*.

CONCLUSION

Having personally collected *J. acutimarginatus* at Boca Chica Key, and have received shell photographs and photographs of data slips from Paul Kersten, Pascal Wink and Bill Fenzan and along with the information in the book by Petuch and Sargent it is my opinion that if Vink would have also had access to this knowledge the type locality of *J. acutimarginatus* would have not been changed. The label on the holotype described by Sowerby II in 1866 only states "Florida," however Mrs. Tombe Taylor was known to have lived in the lower Florida Keys.

With the specimens that I have seen all having come from the Middle to Lower Florida Keys the reasonable conclusion that can be drawn is that *J. acutimarginatus* is a part of the Florida Keys Marine molluscan fauna and that this warrants a change of the type locality back to its original location.

I personally find it difficult to believe that this small *Jaspidiconus* could exist both in Florida and in Venezuela, when one takes these three things into consideration:

1. these two areas are separated by over 1,500 miles;
2. to my knowledge no specimens have been recorded as being found in any location between the Florida Keys and Venezuela which would indicate a species dispersal;
3. *Jaspidiconus* hatch from eggs laid on the substrate and are direct developers and as therefore species dispersal is generally over a small localized area.

John Tucker did a review of the Vink papers and noted therein that he found no records of specimens of *J. acutimarginatus* from eastern Venezuela (Tucker, 2010). While I have never personally seen a cone shell labeled as *J. acutimarginatus* from Venezuela as I am writing this, I strongly suspect that if they are labeled as being from that locality that they are either mislabeled or mis-identified. Perhaps they are *J. jaspideus* or a yet undescribed species. If the later proves to be the case, I would recommend naming that species "*Jaspidiconus vinki*" after Danker L.N. Vink.

Being that many of the *Jaspidiconus* species were all previously unceremoniously grouped together under the single species name *J. jaspideus*, and due to a lack of readily available information about *J. acutimarginatus*, I would recommend that others revisit their collections and check those specimens from Florida labeled as *J. jaspideus* to see if perhaps you might have had this small gem in your collection all along and were just unaware of it's proper identification.

ACKNOWLEDGEMENTS

I would like to thank the following people for their assistance in this paper: Edward J. Petuch for shell identification and encouragement, Paul Kersten, Pascal Wink and Bill Fenzan for their locality information and for permission to use their photos herein, and David P. Berschauer for photo plate layout and guidance.

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ISSUE 1

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In Memory of David Leighton

Buzz Owen

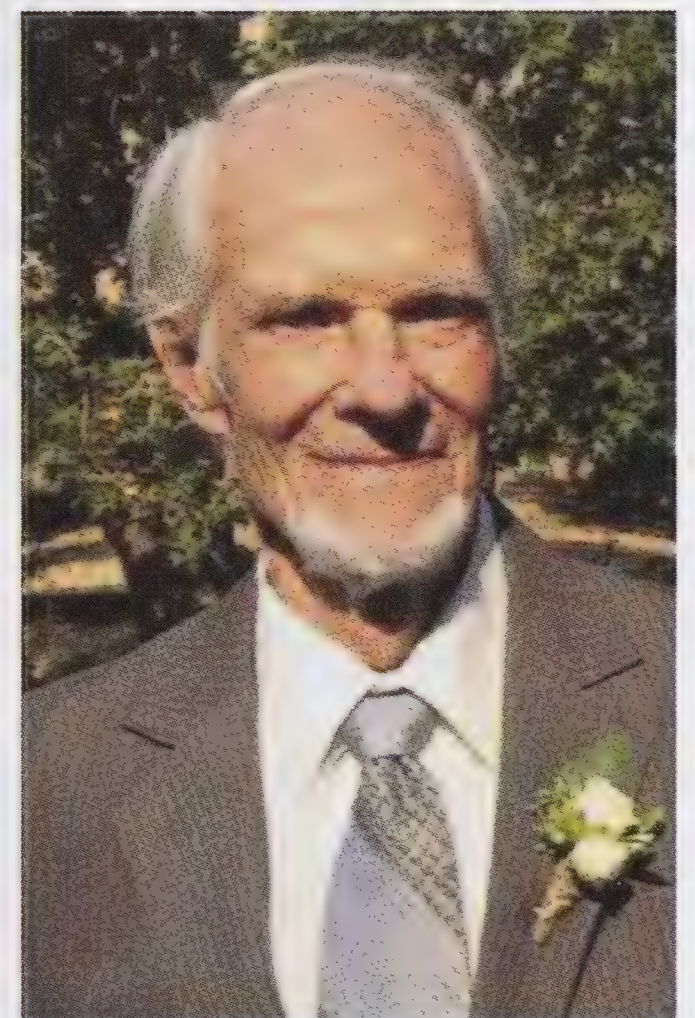
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David Leighton was born on January 5, 1933 and passed away on November 1, 2017 and I was fortunate to know this extremely kind and humble man for more than fifty years. I first became acquainted with David when we independently ventured into the field of hatchery cultivation of California abalone within months of each other in the mid-1960's. David literally 'wrote the book' on how to do this and it was published in 2000 titled "The Biology and Culture of the California Abalones". David dedicated much of his life to the preservation of abalone in California and the Abalone Farm in Cayucos that he helped establish in 1967 is still in operation.

David was an incredibly positive and kind soul who after volunteering a couple of years of his life in the U.S. Army earned multiple advanced degrees to include a Ph.D. from the Scripps Institute of Oceanography, and I have a several endearing examples to share of his humble demeanor. Though my foray into hatchery cultivation slightly preceded Dr. Leighton's, it was relatively short-lived compared to David's and the goal that I achieved was to demonstrate that hybrid abalone could be produced in lab settings. David and I were in close touch during those years and when, years later, he gave me a copy of his aforementioned book, he inscribed it with "*To Buzz Owen - The real pioneer in California Abalone Culture. Your friend, Dave Leighton.*" Being regarded by my friend and colleague David as "the real pioneer" was truly touching. Though David's focus in abalone culture was primarily for preservation of red and green abalone, he did run an experiment in which he crossed green and white abalone gametes. Only two animals survived from that experiment and David grew them out. What is so significant about this hybrid combination is that it has never been encountered in nature (likely because these species inhabit extremely different depths). What is beyond kind about this is that David gave me both of the shells from these animals.

David and I co-authored a couple papers and I had to insist he be 'first author' on one of them even though he was trying to bestow this designation on me. Sometimes establishing 'first' author is a bone of contention between collaborators - not with David - even when he deserved it. David's kind and giving nature was appreciated by all that knew him and he also had a very wry sense of humor. David was a great man, a good friend, and a true pioneer and champion of hatchery cultivation - his friendship, expertise and gracious spirit will be dearly missed.



November General Meeting, Elections, and Exclusive Private Auction of the Pratt Collection

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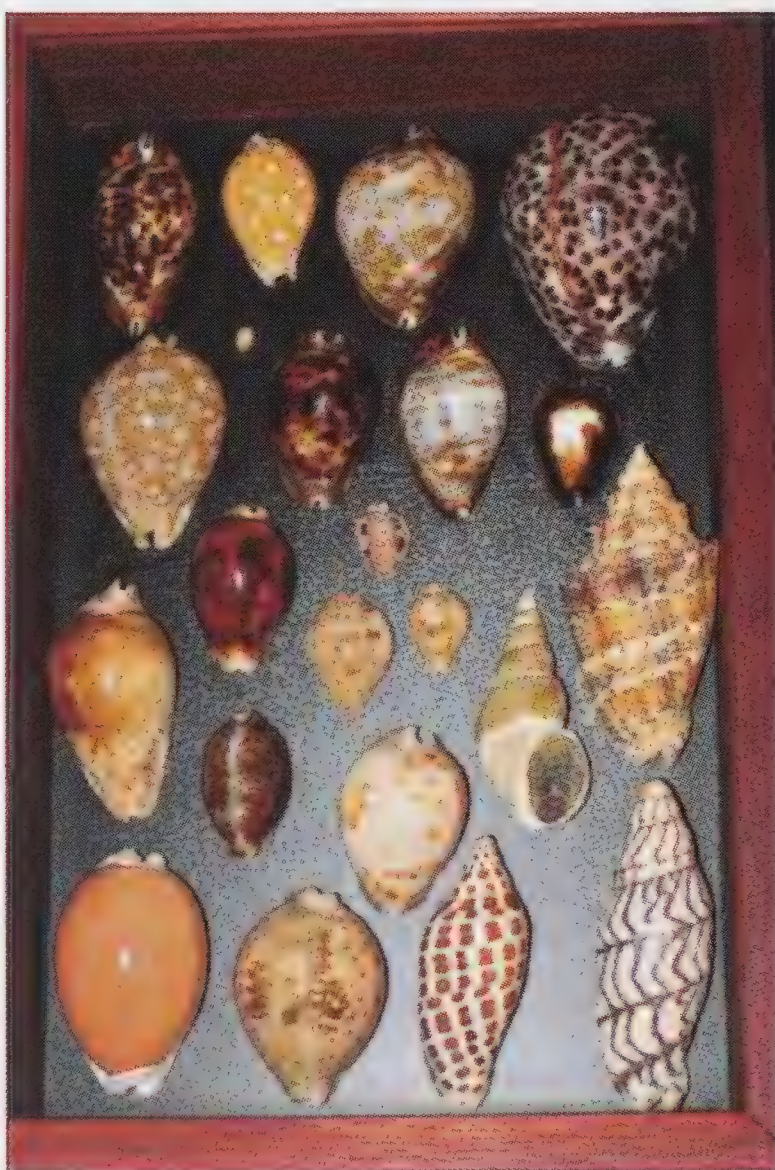
On November 18, 2017, the San Diego Shell Club held a legacy auction of the Pratt Collection from Palo Alto, California. The meeting and auction were hosted by David and Felicia Berschauer at their home in Laguna Hills. The Board members had previously negotiated a contract with the estate for the sale of this special collection, and Charles Powell inspected the collection, supervised and assisted in packing it for shipment to Southern California. The shells arrived a week before the auction and a Club work crew consisting of Lisa Dawn Lindahl, Leo Kempczenski, Scot Lewis, William Schramm and David P. Berschauer spent two days unpacking and sorting specimens for the auction. The collection consisted of over twenty five large bins of coral and rare and unusual shells from around the world, including cowries, cones, volutes, pectens, olives, and land snails. Paul Pratt (the collector) had a 148 page handwritten species list which accompanied the collection. The Board selected shells from this enormous collection for the auction. Julian Lee and Leo Kempczenski then worked on pricing. The day before the auction the collection's steward Ms. Patricia Hart and her broker Sophia Delacotte flew down from the Bay area for the auction.

Over one hundred live auction shells were arranged in decorative hardwood display boxes with lucite covers, and over sixty-five lots of silent auction shells were spread out on tables for viewing and bidding. Club members brought food and beverages which were enjoyed while people viewed the shells, mixed and mingled.



The general meeting was opened, the slate of officers for the 2018 calendar year were announced. There being no write in candidates or nominations from the floor, the members voted to elect the 2018 Board as follows: David B. Waller, President; David P. Berschauer, Vice-President; "Duffy" Daughenbaugh, Treasurer; Leo Kempczenski, Recording Secretary; and, Jill Spofford, Correspondence Secretary. Three members-at-large were elected to assist with COA 2018: Lisa Dawn Lindahl, William Schramm, and Rick Negus. The general meeting closed and the auction promptly began.

The live auction was conducted by David P. Berschauer and David B. Waller as auctioneers. Close to thirty Club members were in attendance and while it remained friendly the bidding was fierce at times. Several people from out of state (or out of the country) bid on shells by proxy. In the end all of the live auction shells sold and the Club was pleased to be able to provide Ms. Hart with a sizable check for the items sold at the auction. The remainder of the sizeable Pratt Collection that was not auctioned off that afternoon was gifted to the Club by Ms. Hart for its use in future auctions. It was a very successful auction and the Club members in attendance had a great time and everyone went home with some wonderful shells.



The Club's Annual Holiday Party

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The Club's annual holiday party was held on Saturday afternoon at David and Viviane Waller's home on December 9th 2017 and it was a great time for all who participated. There were over 20 Club members attending the event and all were engaging in conversation with friends and new members they just met. Some were talking about shells, others were talking about the good old days, but they all were enjoying themselves.

The delicious food was brought in from 50 miles away and it was surprising how hot it was on arrival. There were plenty of ribs, chicken, mash potatoes, baked beans, braised greens, and even a special vegetarian meal for Bill Schramm.

David Berschauer thanked all of the 2017 Board members for their hard work and dedication, some who have been serving for several years. He then introduced/installed the members of the 2018 Board: David Waller, President; David Berschauer, Vice President; Duffy, Treasurer; Jill Spofford, Corresponding Secretary; and Leo Kempczenski, Recording Secretary.

A high point in the day's festivities was a visit to David Waller's Cowry collection. Several transparent wall mounted cabinets with each shell in it's own Lucite box makes for a very impressive display.

Towards the end of the party Dr. Paul Tuskes gave a great talk on "Traveling in the Gulf" and discussing the shells and other marine life. Many of the under water pictures were stunning.

Then there was the traditional gift exchange -- those who brought a gift got to choose one. It was enjoyable to see what others got for their shell exchange. All in all it was a great San Diego Shell Club event. If you missed it, then you better make plan to attend this year's party.



Looking Forwards - COA 2018

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This year's Conchologists of America Convention will be hosted by the San Diego Shell Club at the Sheraton San Diego hotel from August 29th to September 2nd, 2018. This convention's week of shelling fun comes right after the conclusion of the West Coast Shell Show so that shellers can enjoy both events. There will be field trips on Monday and Tuesday, August 27th and 28th to interesting venues like San Diego Seaport Village, Balboa Park, Scripps Aquarium, a San Diego dinner cruise, and a tour of the U.S.S. Midway. Convention goers who do not want to go on organized trips can explore on their own and visit any number of attractions and interesting sites, including Old Towne San Diego, the Gas Lamp District, Seaworld, Legoland, the San Diego Wild Animal Park, wineries, and many more.

The theme of this year's convention will be "*treasures of the sea*." Following the opening ceremonies and a silent auction the welcome party will take place on the evening of August 29th. There will be a "funny hat" contest at the welcome party so be sure to wear an interesting hat to the welcome party. The convention goes into full swing the next day. Following two action packed days of interesting shell related programs, silent auctions and an oral auction - all with amazing rare and unusual shells. Once again there will be many fantastic selected shells from the Frederic Weiss legacy collection which was donated to COA last year and which contributed to some amazing auctions in Key West, Florida. Many of the member shell clubs will have tables at this event with souvenirs including t-shirts, shells, books, pins and more.

There will be a sumptuous banquet on the evening of August 31st. The logo for this year's COA Convention is a Pacific Octopus wrapped around a Red Abalone (*Haliotis rufescens*) with a Catalina Trophon (*Austrotrophon catalinensis*) in the foreground; this is an original piece of artwork painted by our very own Lisa Dawn Lindahl (*see* this issue's back cover), and the painting will be auctioned off at the oral auction the evening of August 31, 2018.

The dealers' bourse will take place on September 1st and 2nd so be sure to attend and gaze upon the wonders of the seas brought to our shores by veteran shell dealers from around the world. Be sure to attend the bourse, view the treasures of the sea, and support your favorite dealers.

Special thanks in advance to all of the volunteers of both COA and the SDSC who are working hard to will make this a great event.



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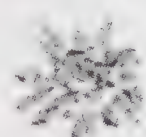
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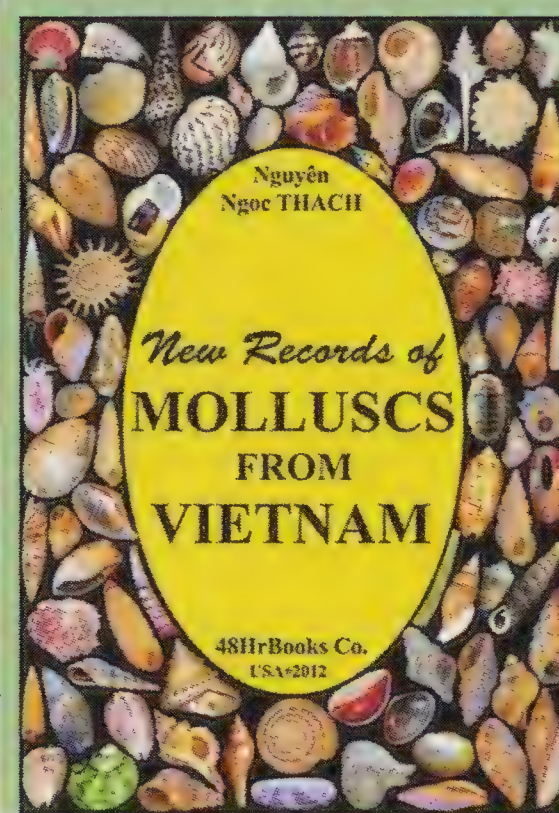
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THE FESTIVUS

ISSUE 1

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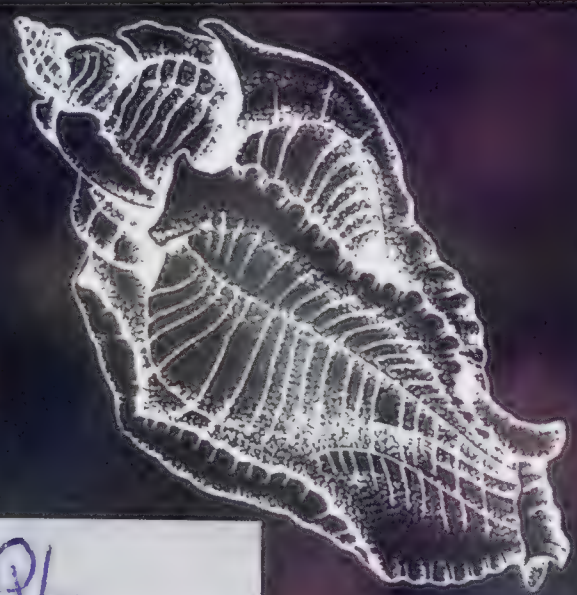
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THE Festivus

Vol. 50(2)

May 2018

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Cape Verde cones

Shells from Namibia, Australia, and Cuba

***Marginella* from South Africa**

Landsnail range extension from Vietnam

Quarterly Publication of the San Diego Shell Club



THE FESTIVUS

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Volume: 50

May 2018

ISSUE 2

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REGULAR CLUB MEETINGS

Club meetings are held on the third Thursday or Saturday of the month, except April, September and December, at either 7:30 p.m. in Room 104, Casa del Prado, Balboa Park, San Diego, or at 12:00 noon at other locations as noticed.

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FRONT COVER:

Live specimen of *Palmadusta artuffeli* (Josseaume, 1876) *in situ*, on rocks with egg mass in Japan, photo courtesy of Rob Rodolico. (Cover digital artistic credit: Rex Stilwill).

MISSION STATEMENT

The San Diego Shell Club was founded in 1961 as a non-profit organization for educational and scientific purposes. More particularly to enjoy, study and promote the conservation of Mollusca and associated marine life through lectures, club meetings and field trips. Our membership is diverse and includes beginning collectors, scientists, divers, underwater photographers and dealers.

THE FESTIVUS is the official quarterly publication of the San Diego Shell Club, Inc. and is issued as part of membership dues in February, May, August and November. *The Festivus* publishes articles that are peer reviewed by our volunteer Scientific Peer Review Board, as well as articles of general interest to malacologists, conchologists, and shell collectors of every level. Members of the Peer Review Board are selected to review individual articles based upon their chosen field of expertise and preference. Available by request or on our website are:

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 COA 2018 in San Diego: 8/29 - 9/2/2018
 November Shell Auction: 11/17/2018 from 1:00 p.m.
 Holiday Party: 12/8/2018 from 1:00 p.m.

Publication date: May 1, 2018
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If you have not already done so be sure to register for the COA this year in San Diego.



COA 2018 pin design

Identification of new species of *Kalloconus* and *Africonus* (Gastropoda, Conidae) from the Cabo Verde Islands through mitochondrial genome comparison

Manuel J. Tenorio,¹ Samuel Abalde,² and Rafael Zardoya²

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ABSTRACT

The new species *Kalloconus marimaris* sp. nov. and *Africonus angeluquei* sp. nov. are described from the material obtained during the MNCN sampling campaigns at the Cabo Verde Islands. The new species have been characterized by examination of their shell and radular teeth morphology and by the comparison of mitochondrial genomes obtained through next-generation DNA sequencing techniques. Phylogenetic analyses suggest that *K. marimaris* sp. nov., known from Sal Island, is a sister species to *Kalloconus ateralbus*, whereas *A. angeluquei* sp. nov. from Maio Island is a sister species to *Africonus josephinae* and *Africonus borgesii* from Boa Vista Island. The estimated genetic distances were consistent with the full species rank for the new taxa described herein.

INTRODUCTION

The Cabo Verde Archipelago is renowned for the high number of endemic cone snail species (Rolán 1990, Monteiro *et al.* 2004, Cunha *et al.* 2005, Duda & Rolán 2005, Peters *et al.* 2016). As a result of the systematic sampling of cone snail populations across the Cabo Verde archipelago, we have been able to reconstruct a statistically robust phylogeny based on almost complete mitochondrial genomes (consisting of 10,000 to 16,000 DNA base pairs) and using probabilistic methods that include most of currently accepted species. Mitochondrial genomes compare to partial gene sequences provide robust phylogenetic inferences with highly resolved trees below the family level (Abalde *et al.* 2017 and references therein). Based on the reconstructed phylogeny and on genetic distance comparisons, the taxonomic status of the analyzed cone species was revised: DNA sequence divergences below or above a given threshold allowed for postulating

synonyms or confirming valid species, respectively (Abalde *et al.* 2017). In this fashion, and regardless of the large amount of names introduced in recent years for different Cabo Verde cone snail populations, the number of valid species for the archipelago was reduced to about one half. Nevertheless, some cone populations, which showed sequence divergences above the threshold, did not correspond to any of the already named species. By following this criterion, the new species *Africonus freitasi* Tenorio, Afonso, Rolán, Pires, Vasconcelos, Abalde & Zardoya, 2017 was recently described based on two populations previously reported from São Vicente Island (Röckel *et al.* 1980, Rolán 2005). Similarly, we found several populations of *Kalloconus* from Sal Island, and of *Africonus* from Maio Island, which exhibited DNA sequence divergences consistent with the hypothesis of separate species, yet formally undescribed. Therefore, we hereby introduce these new species with the respective names *Kalloconus marimaris* sp. nov.

and *Africonus angeluquei* sp. nov. The morphological features of the shells of the new species are compared with those of their sister taxa in the phylogeny, namely *Kalloconus ateralbus* (Kiener, 1845) (Figure 1A) and *Africonus josephinae* (Rolán, 1980) (Figure 1C) plus *Africonus borgesii* (Trovão, 1979) (Figure 1D).

MATERIAL AND METHODS

Taxonomy follows Tucker & Tenorio (2009) with the updates and modifications based on Tucker & Tenorio (2013) and Abalde *et al.* (2017). The specimens studied were collected by snorkeling during campaigns carried out by the MNCN in the Cabo Verde Islands between 2013 and 2014, at depths between 1–3 m. Distribution maps were generated using GeoMapApp (<http://www.geomapapp.org>) using the global multi-resolution topography (GMRT) as default basemap.

We describe shell morphology using the terminology established in Röckel *et al.* (1995). For morphometric comparisons, adult shells

were measured using digital calipers, with measurements rounded to 0.1 millimeter. For comparison of shell morphometry, the analysis was performed using analysis of covariance (ANCOVA) for the corresponding morphometric trait, using species hypotheses as factor and aperture height (AH) as co-variate. Statistical tests were carried out using STATGRAPHICS CENTURION XVII, once all the measurement sets passed the normality tests.

We used the terminology for radular morphology of Tucker & Tenorio (2009), and the abbreviations in Kohn *et al.* (1999). The radular sac was dissected from the cone snail and soft parts were digested in concentrated aqueous potassium hydroxide for 24 hours. The resulting mixture was then placed in a Petri dish and examined with a binocular microscope. The entire radula was removed with fine tweezers and rinsed with distilled water, then mounted on a slide using Aquatex (Merck) Mounting Medium, and examined under a compound microscope. Photographs were obtained with a CCD camera attached to the microscope.



Figure 1. A) *Kalloconus ateralbus*, 42.3 mm, Calheta Funda, Sal Island, MNCN; B) *Kalloconus venulatus*, 50.7 mm, Morro de Areia, Boa Vista Island, MNCN; C) holotype of *Conus josephinae*, 25.8 mm, Sal-Rei, Boa Vista Island, MNCN; D) holotype of *Conus borgesii*, 26.1 mm, Baía das Gatas, Boa Vista Island, NHMUK; E) *Africonus josephinae* f. *guiandradoi*, mm, paratype 4, 24.3 mm, off NE Sal Rei, Baixa da Hortinha, Boa Vista Island, Paul Kersten coll., Hoornaar, The Netherlands.

DNA sequences are from Abalde *et al.* (2017). Nucleotide sequences of the 13 mitochondrial (“mt”) protein-coding and two rRNA genes were aligned independently using Translator X (Abascal *et al.* 2010) and MAFFT v7 (Kato & Standley 2013), respectively. All aligned genes were combined in a single dataset. Uncorrected *p* distances were estimated using MEGA (Kumar *et al.* 2016). Phylogenetic relationships were inferred using maximum likelihood (ML) and Bayesian inference (BI). For ML, we used RAxML v8.1.16 (Stamatakis 2006) with the rapid hill-climbing algorithm and 10,000 bootstrap pseudoreplicates (BP). For BI, we used MrBayes v3.1.2 (Ronquist & Huelsenbeck 2003), running 10 million generations, sampling every 1000 generations, and discarding the first 25% generations as burn-in. Best-fit partition schemes and substitution models were identified using PartitionFinder2 (Lanfear *et al.* 2017). Node support was estimated based on Bayesian posterior probabilities (BPP). The amphiatlantic *Chelyconus ermineus* was used as outgroup. *Lautoconus ventricosus* from Portugal, and *Kalloconus pulcher* from Senegal were included as representatives of the closest sister groups of Cabo Verde *Africonus* and *Kalloconus*, respectively.

Abbreviations

Museums and private collections

MNCN: Museo Nacional de Ciencias Naturales, Madrid, Spain.

MNHN: Muséum National d’Histoire Naturelle, Paris, France.

MHNS: Museo de Historia Natural de la Universidad de Santiago de Compostela, Spain.
NHMUK : Natural History Museum, London, UK.

UCV: reference collection of the University of Cabo Verde, Mindelo, Cabo Verde.

MJT: reference collection of Manuel J. Tenorio, Jerez, Spain.

CMLA: reference collection of Carlos M. L. Afonso, Algarve, Portugal.

Shell morphometry

S_L maximum shell length

MD maximum diameter

SH spire height

HMD height of maximum diameter

AH aperture height

RD relative diameter ($= MD/AH$)

RSH relative spire height ($= SH/S_L$)

PMD relative position of the maximum diameter ($= HMD/AH$)

Radular morphometry

B_L blade length

S_L/T_L shell length/radular tooth length

T_L/AP_L radular tooth size/anterior portion length

$100B_L/AP_L$ 100 x blade length/anterior portion length

RESULTS

SYSTEMATICS

Family CONIDAE Fleming, 1822

Genus *Kalloconus* da Motta, 1991

Kalloconus marimaris sp. nov.

(Plate 1, Figures A–M)

Conus ateralbus – Monteiro *et al.* 2004: pl. 47, figs. 2, 5 & 7; pl. 48, figs. 1-7; pl. 49, figs. 1-6 (not *Conus ateralbus* Kiener, 1845).

Conus venulatus – Monteiro *et al.* 2004: pl. 52, figs. 1 & 3; Rolán 2005: pl. 49, figs. 744- 746 (not *Conus venulatus* Hwass in Bruguière, 1792).

Type material: Holotype and 14 paratypes. The holotype is deposited in the Museo Nacional de Ciencias Naturales, Madrid, Spain, under the number MNCN 15.05/79664, *see* Table 1 for details. Additional uncataloged paratypes are in the reference collection of MJT.

Type	Institution	Dimensions (mm)	Locality
Holotype	MNCN 15.05/79664	38.6 x 23.9	Serra Negra, Sal Island, Cabo Verde Islands, 16°38'16.5"N, 22°53'56"W, 1-3 m.
Paratype 1	MNCN 15.05/79666	37.2 x 23.1	same data as the holotype
Paratype 2	MNCN 15.05/79671	29.7 x 19.6	same data as the holotype
Paratype 3	MNHN-IM-2014-6899	30.9 x 17.6	same data as the holotype
Paratype 4	MNCN 15.05/79668	31.7 x 21.6	same data as the holotype
Paratype 5	MNCN 15.05/79674	28.3 x 17.3	same data as the holotype
Paratype 6	MNCN 15.05/79676	27.3 x 17.6	same data as the holotype
Paratype 7	MNCN 15.05/79680	40.1 x 27.4	Rabo de Junco, Sal Island, Cabo Verde Islands, 16°41'44"N, 22°58'35"W, 1-3 m.
Paratype 8	MNCN 15.05/79684	39.8 x 27.6	same data as paratype 7
Paratype 9	MNCN 15.05/79689	36.6 x 22.9	same data as paratype 7
Paratype 10	MNCN 15.05/79699	40.9 x 24.2	Murdeira, Sal Island, Cabo Verde Islands, 16°40'43"N, 22°56'10"W, 1-3 m.
Paratype 11	MNCN 15.05/79688	41.5 x 27.1	same data as paratype 7
Paratype 12	MHNS 100636	36.2 x 22.6	same data as paratype 7
Paratype 13	UCV 2018/00005	33.9 x 21.9	same data as paratype 7
Paratype 14	CMLA	40.3 x 24.9	same data as paratype 7

Table 1. Detailed listing of type specimens.

Material examined: A total of 49 specimens from separate populations to the east (Serra Negra) and west (Rabo de Junco and Murdeira) coasts of Sal Island, Cabo Verde archipelago have been studied. Most specimens are deposited at the MNCN collection.

Type locality: Serra Negra, Sal Island, Cabo Verde archipelago, 16°38'16.5"N, 22°53'56"W, 1–3 m.

Distribution and habitat: The species is endemic to Sal Island, Cabo Verde archipelago, where it has been collected in the east (Serra Negra) and west (Murdeira to Rabo de Junco) coasts of the island in shallow water (from a few centimeters down to 5 m) (Figure 2). The populations from both sides of the island are isolated from each other, and exhibit subtle morphological differences in shell pattern. The species lives half-buried in sand among rocks (Figure 3).

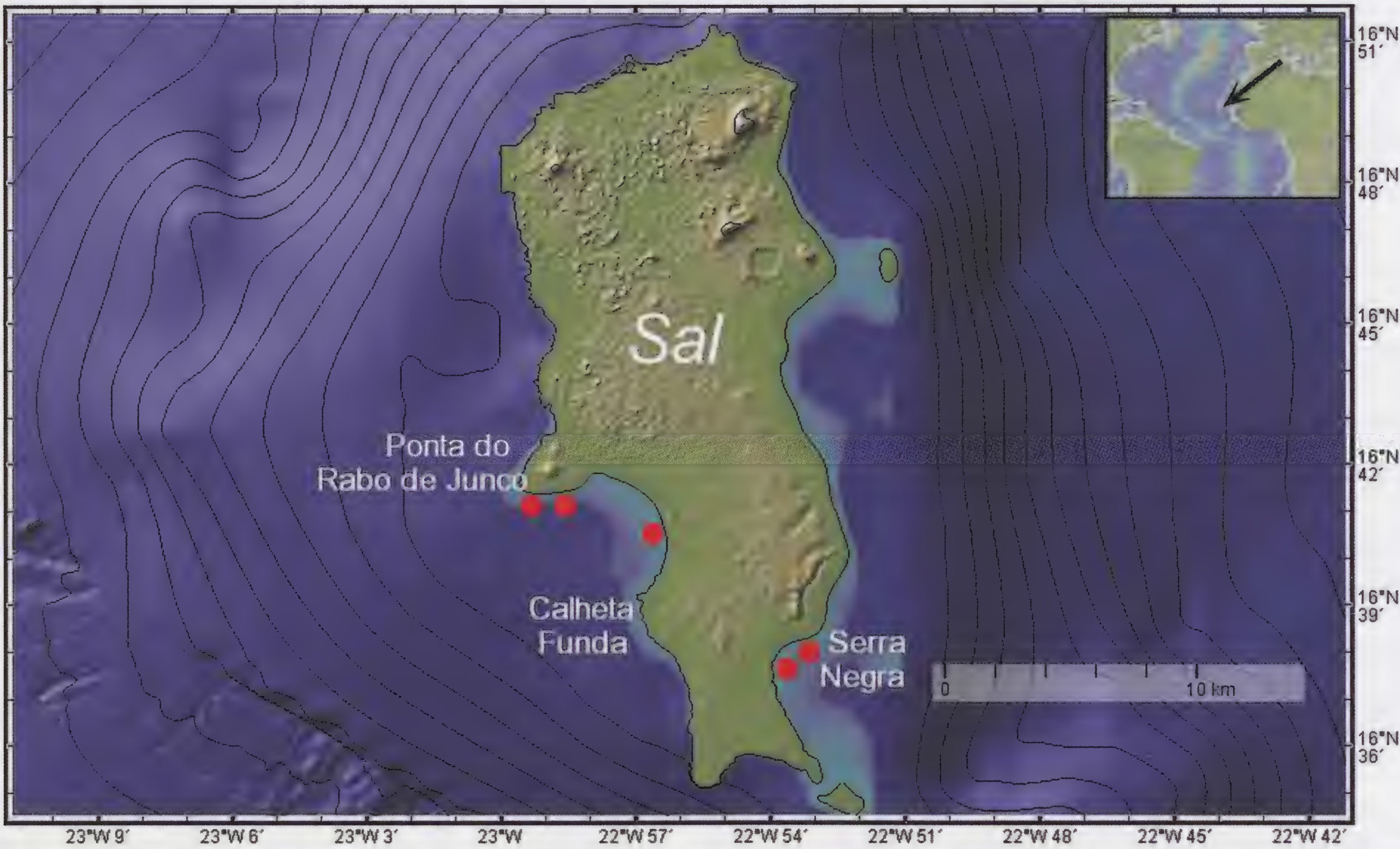


Figure 2. Distribution map for *Kalloconus marimaris* (red circles). Symbols indicate the points where the species has been sampled. The bathymetric levels are represented by curved lines.



Figure 3. *Kalloconus marimaris* sp. nov. alive in natural habitat, Rabo de Junco, Sal Island (photo credit: Carlos M. L. Afonso).

Etymology: Named after Maria del Mar Albarrán, sister-in-law of the first author, who recently and prematurely passed away. Known as Marimar by family and friends, she was a beloved wife and mother, with devotion for the sea and especially for the beautiful beaches of the Atlantic coast of her native province of Cadiz.

Description of the shell: Morphometric parameters: $S_L = 25\text{--}45$ mm; mean $S_L = 35.5$ mm; $RD = 0.70\text{--}0.79$; $RSH = 0.09\text{--}0.21$; $PMD = 0.81\text{--}0.89$.

Shell moderately small to medium-sized. Profile broadly and ventricosely conical to broadly conical. Protoconch paucispiral, white at the nucleus with yellowish early whorls. Early postnuclear whorls and late teleoconch whorls smooth. Spire of moderate height, most often heavily eroded, of straight or slightly sigmoid profile. Teleoconch whorls flat or slightly concave. Cords are absent. Shoulder subangulate to angulate. Last whorl sides straight or slightly convex. Aperture narrow, white, and of uniform width. Pattern of the last whorl very variable. Most often chestnut brown with small triangular white markings, but there are also specimens orange or pinkish-white in color. White triangular markings arranged in one broad spiral band in the center of the last whorl, flanked above and below by spiral areas showing little or no pattern. Other two spiral bands of white triangular markings are often present near the shoulder and the base respectively, although these are not as dense as the central band, and might be even absent in some specimens. Thin, equally-spaced spiral lines of a darker shade of the ground color (brown or orange) may be present, specially in specimens from western coast populations. Spire pattern consisting of alternating white and ground color (brown or orange) irregular blotches. In general, there is a large variability

in color and pattern (*see* Plate 1). Periostracum yellow, thin and translucent. Operculum small and rounded.

Living animal and radula: The animal is light purplish with areas of a darker purple color, specifically the tip of the siphon. 30 to 38 teeth in radular sac. Radular tooth (Figure 4A, B) of the vermivorous type, of medium relative size ($S_L/T_L = 45\text{--}54$), with a short barb, not very marked. Waist not very well marked but evident. Anterior and posterior sections are essentially equal in length ($T_L/AP_L = 1.9\text{--}2.0$). Blade rounded, covering most of the anterior section ($100B_L/AP_L = 65\%$ to 80%). Serration with 20 - 31 denticles arranged in one row, becoming two rows below. The serration ends in a small terminating cusp. The denticles are rather coarse in the apical portion, becoming small and even obsolete in the lower third. Base rather broad, with a small spur.

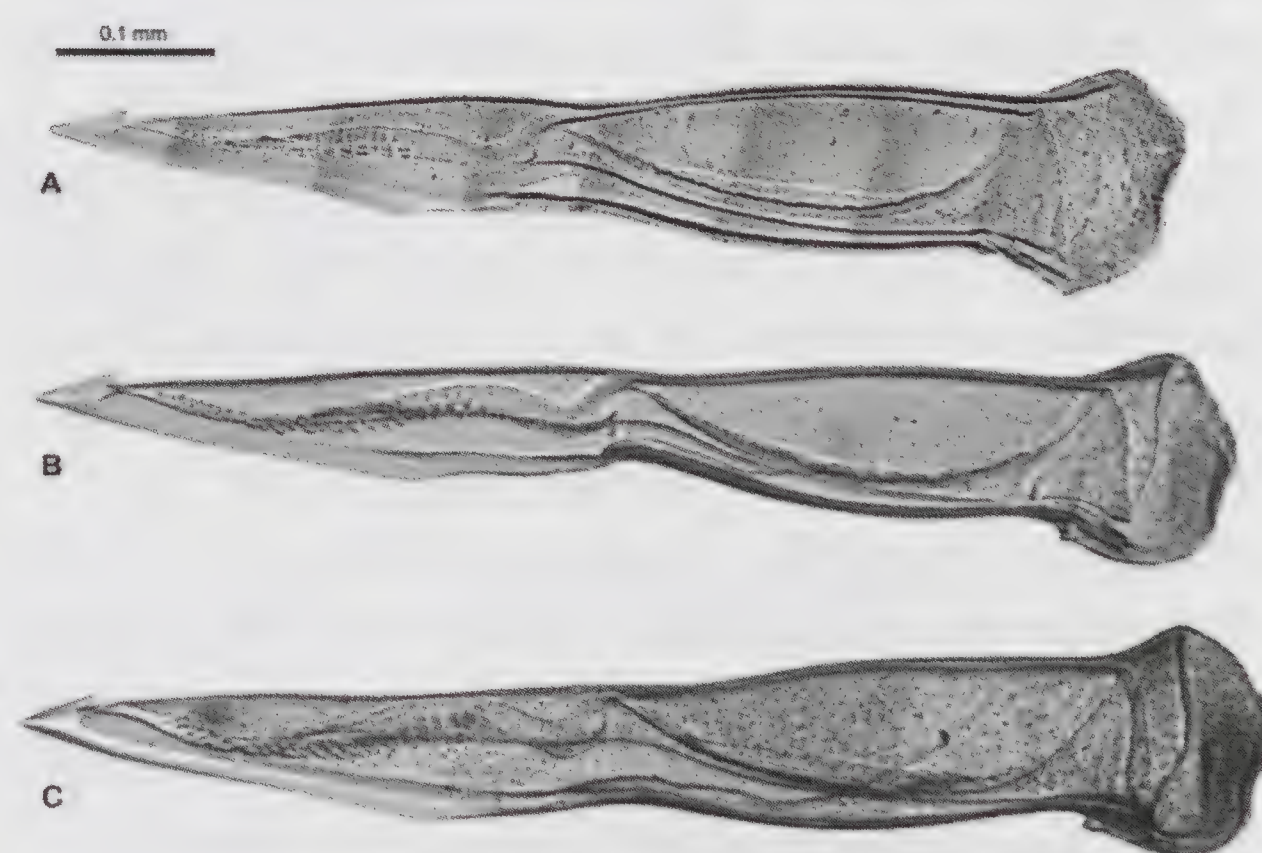


Figure 4. Radular teeth of: A) *K. marimaris* sp. nov., Serra Negra, Sal Island, S_L 33.1 mm; B) *K. marimaris* sp. nov., Rabo de Junco, Sal Island, S_L 38.0 mm; C) *K. ateralbus*, Calheta Funda, Sal Island, S_L 39.5 mm.

DIFFERENTIAL DIAGNOSIS

Kalloconus marimaris sp. nov. is similar to *K. ateralbus* (Kiener, 1845) (Figure 1A), and it has been previously figured in the literature as the latter species. Indeed, both species are very similar in shape, size, and morphology of the radular teeth (Figure 4). The slight differences in the morphometric parameters of shell and radula are not statistically significant. However, the two species are molecularly distinct. This was already suggested by phylogenetic studies on population genetics of the species in the *Kalloconus venulatus* (Hwass in Bruguière, 1792) group based on partial gene sequences (Cunha *et al.* 2008), and the splitting at the species level is hereby confirmed by analyzing mt genomes. In a well-resolved and highly supported phylogenetic tree (Figure 5), both species are recovered as sister taxa, separated by an uncorrected *p* distance of ca. 1.1 %. Specimens from the populations of Serra Negra and Rabo de Junco appear clustered together (*p* distances <0.1%), as sister group to *K. ateralbus*. The most evident morphological features for the separation of *K. marimaris* sp. nov. and *K. ateralbus* are related to shell background color and pattern, as well as to the color of the aperture. Thus, the background color of *K. ateralbus* is black, with a pattern of white triangular markings most often arranged as a midbody broad spiral band. There is some variability in the extent of the distribution of the white triangular markings in the body whorl, but the background color is constant. In the case of *K. marimaris* sp. nov., the background color is variable, ranging from dark brown to orange, yellow or even milky white. The aperture in *K. marimaris* sp. nov. is white, but purplish in the case of *K. ateralbus*. The two species have separate areas of distribution. *K. ateralbus*

seems restricted to the SW of Sal Island, in the Bays of Algodoeiro and Calheta Funda. The northern range of its distribution has a contact zone with that of *K. marimaris* sp. nov. in Murdeira Bay. The shell morphology of certain morphs of the molecularly distinct species *K. venulatus* (Figure 1B) (*p* distance 2.4 %) may appear very similar to that of *K. marimaris* sp. nov. Both species share the white-colored aperture, and a high variability in shell color and pattern. However, all the populations of *K. venulatus* are distributed throughout the islands of Boa Vista and Maio, being absent from Sal Island.

Genus *Africonus* Petuch, 1973

Africonus angeluquei sp. nov.

(Plate 2, Figures A–M)

Conus sp. – Röckel *et al.* 1980: p. 141, fig. 123; pl. 2, 2nd row, figs. c, d.

Conus josephinae – Monteiro *et al.* 2004: pl. 110, figs. 1–6 (not *C. josephinae* Rolán, 1980).

Type material: Holotype and 14 paratypes. The holotype is deposited in the Museo Nacional de Ciencias Naturales, Madrid, Spain, under the number MNCN 15.05/78710. See Table 2 for details. Additional uncataloged paratypes are in the reference collection of MJT.

Material examined: More than 50 specimens from several locations in Maio Island, Cabo Verde archipelago, have been studied. These specimens are deposited in the MNCN, MJT and CMLA collections.

Type locality: Lage Branca, Baia do Galeao, Maio Island, Cabo Verde archipelago, 15°18'32"N, 23°8'18"W, 1–3.

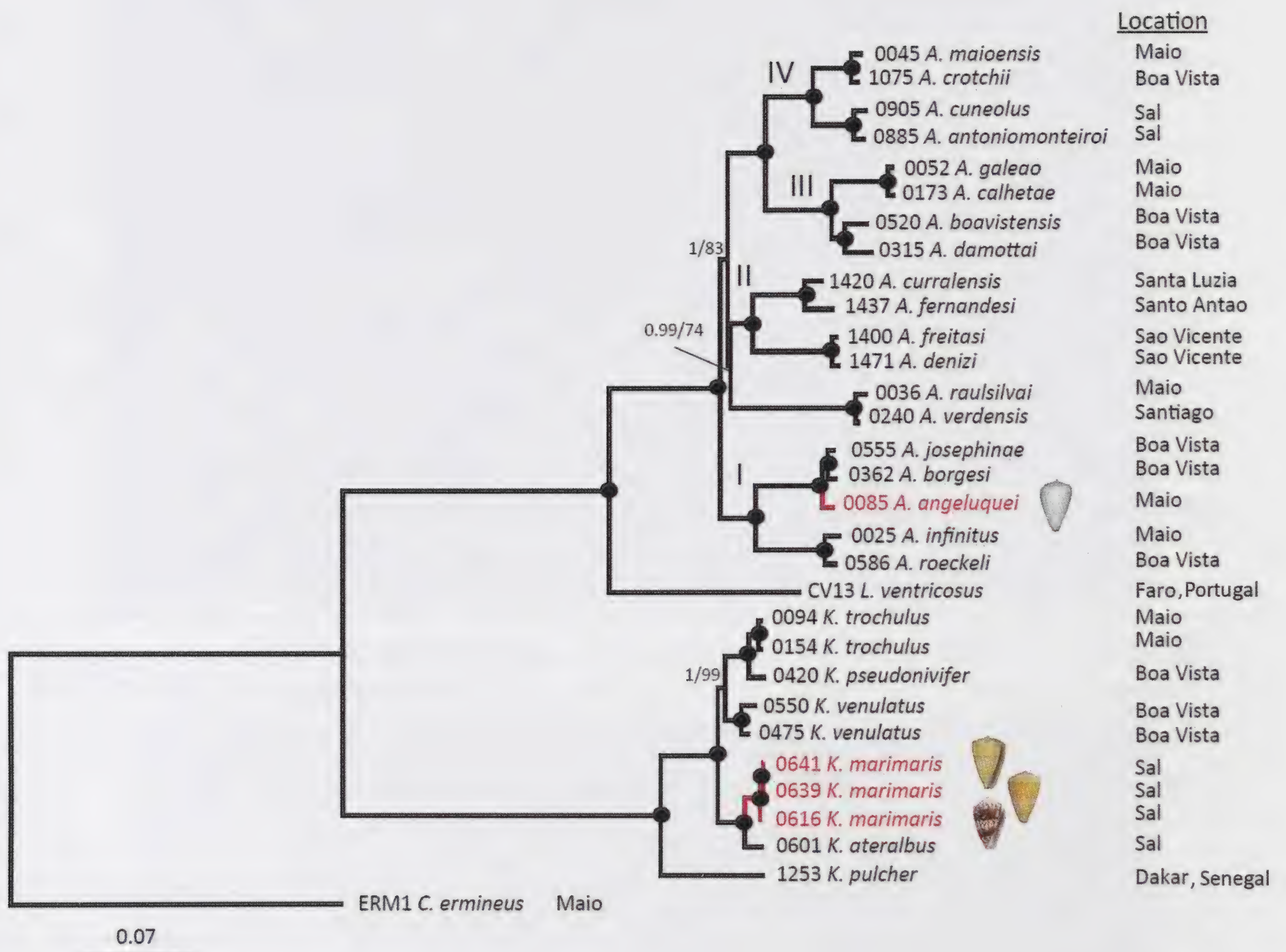


Figure 5. Phylogeny of cones endemic to Cabo Verde archipelago based on almost complete mitochondrial genomes (concatenated protein coding plus rRNA genes analyzed at the nucleotide level). Numbering of specimens follows Abalde *et al.* 2017. Their geographical distribution is indicated. Ventral images of the shell of the new species are provided. Numbers at nodes are statistical support values for BI (Bayesian posterior probabilities, BPP)/ ML (bootstrap proportions, BP). A black dot indicates maximal support (BPP 1/ BP 100%). Scale bar indicates substitutions/site. Four major lineages (I-IV) are recovered within *Africonus* as in Abalde *et al.* 2017. GenBank accession nos. are provided in Abalde *et al.* (2017) except for MH243427 and MH243428 corresponding to individuals 0639 and 0641, respectively.

Type	Institution	Dimensions (mm)	Locality
Holotype	MNCN 15.05/78710	30.0 x 19.0	Lage Branca, Baia do Galeao, Maio Island, Cabo Verde Islands, 15°18'32"N, 23°8'18"W, 1-3 m.
Paratype 1	MNCN 15.05/78708	21.7 x 13.2	same data as the holotype
Paratype 2	MNCN 15.05/78707	18.8 x 12.2	same data as the holotype
Paratype 3	MNHN-IM-2014-6900	24.8 x 15.8	same data as the holotype
Paratype 4	MNCN 15.05/78709	28.4 x 17.6	same data as the holotype
Paratype 5	MNCN 15.05/78713	21.3 x 13.2	same data as the holotype
Paratype 6	MNCN 15.05/78712	21.7 x 13.1	same data as the holotype
Paratype 7	MNCN 15.05/78804	37.8 x 24.0	Praia Real, Maio Island, Cabo Verde Islands, 15°19'45"N, 23°10'39"W, 1-3 m.
Paratype 8	MNCN 15.05/78802	34.0 x 20.7	same data as paratype 7
Paratype 9	MNCN 15.05/78807	30.0 x 20.0	same data as paratype 7
Paratype 10	MNCN 15.05/78714	20.4 x 11.8	same data as the holotype
Paratype 11	MNCN 15.05/78646	24.3 x 14.8	Baía do Pau Seco, Maio Island, Cabo Verde Islands, 15°15'26"N, 23°13'16"W, 1-3 m.
Paratype 12	MHNS 100637	18.1 x 11.3	same data as the holotype
Paratype 13	UCV 2018/00006	18.8 x 12.0	same data as the holotype
Paratype 14	CMLA	25.2 x 15.2	same data as paratype 7

Table 2. Detailed listing of type specimens.

Distribution and habitat: The species has been collected in the west coast (Baia do Pau Seco) and the north coast (Porto Cais, Praia Real and Baia do Galeao) of Maio Island, Cabo Verde archipelago (Figure 6). It has been found under rocks on sand, in 2 to 5 m depth.

Etymology: Named after Dr. Angel Luque del Villar, Associate Professor of Zoology at the Universidad Autónoma de Madrid. Dr. Luque del Villar is a specialist in taxonomy,

systematics, ecology and biogeography of marine gastropods. He also works in various marine benthic communities and in the conservation of marine species and habitats.

Description of the shell: Morphometric parameters: $S_L = 18-34$ mm; mean $S_L = 26.8$ mm; $RD = 0.69-0.79$; $RSH = 0.08-0.16$; $PMD = 0.80-0.87$.

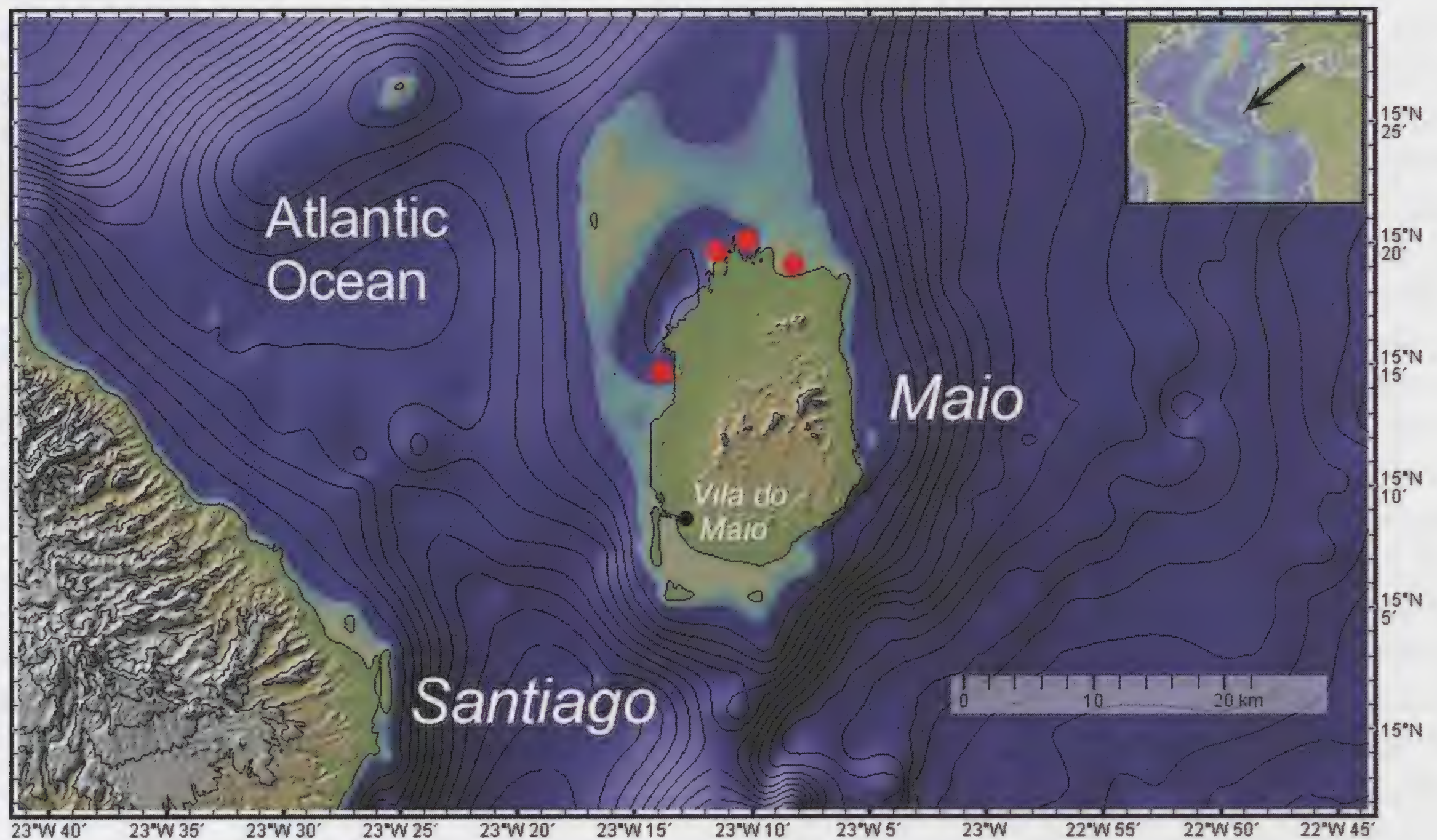


Figure 6. Distribution map for *Africomus angeluquei* (red circles). Symbols indicate the points where the species has been sampled. The bathymetric levels are represented by curved lines.



Figure 7. *A. angeluquei* sp. nov. alive in artificial conditions (photo credit: Carlos M. L. Afonso).

Shell moderately small, broadly and ventricosely conical in shape. Spire is low to moderate and concave in profile. Reddish brown protoconch (when not eroded), paucispiral of 1.25 whorls. Teleoconch sutural ramp flat or slightly convex, with 3-4 cords clearly visible on the early whorls, becoming obsolete in later whorls. Shoulder subangulated to rounded. Aperture white. Shell essentially patternless, of uniform color, which ranges most often from pure white to yellow, and less frequently from light brown to chestnut brown. Some specimens display fine spiral lines in variable number of a darker or lighter color than the background. Occasionally, a change in the color may occur during the growth of the shell, resulting in a bi-colored shell. Periostracum yellow, thin and translucent.

Living animal and radula: The animal has an uniform very dark red color, almost black in appearance (Figure 7). 36 to 38 teeth in radular sac. The radular tooth (Figure 8A) is of the vermivorous type, very broad, and of medium to large relative size ($S_L/T_L = 36-42$). Apical barb small but clearly marked. The anterior portion is shorter than the posterior portion ($T_L/AP_L = 2.2-2.3$). Blade rounded, covering most of the anterior portion ($100B_L/AP_L = 75\%$ to 80%). Serration with 20 to 32 small denticles arranged in two rows, becoming three rows towards the base. Terminating cusp sharp and prominent. Basal spur present.

DIFFERENTIAL DIAGNOSIS

A. angeluquei sp. nov. has been previously identified as the Maio population of the taxon *Africonus josephinae* (Rolán, 1980) (Figure 1C). Indeed, both species exhibit almost identical shell and radular morphologies (Figure 8A,B). However, the phylogenetic analysis (Figure 5) shows that the genetic distance between *A. angeluquei* sp. nov. from Maio and

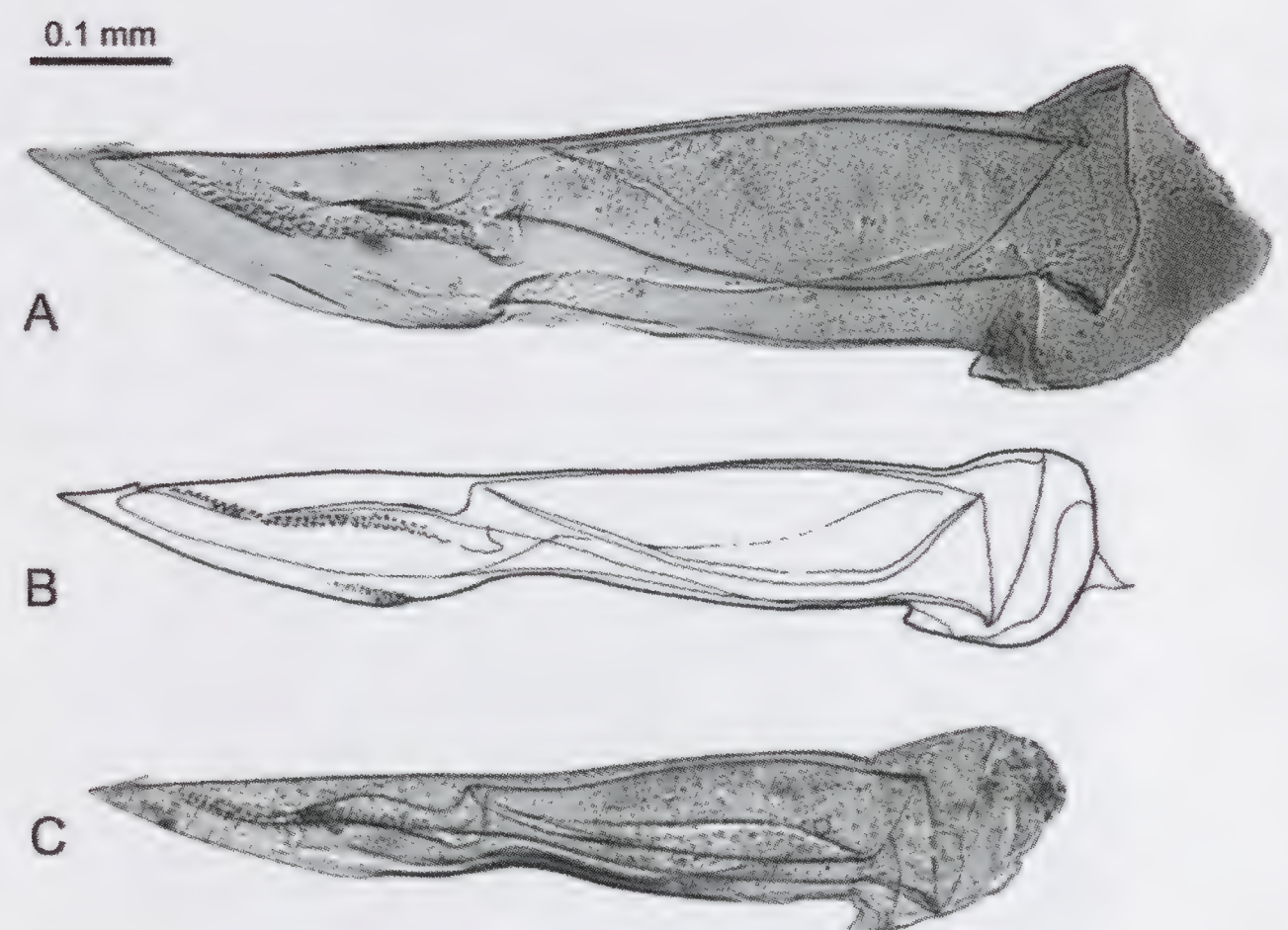


Figure 8. Radular teeth of : A) *A. angeluquei* sp. nov., Praia Real, Maio, S_L 33.0 mm; B) *A. josephinae*, Sal-Rei, Boa Vista, S_L 32.0 mm (drawing by Dr. Emilio Rolán); C) *A. borgesii*, Derrubado, Boa Vista, S_L 23.4 mm.

A. josephinae from Boa Vista (uncorrected p distance of 0.8 %) is consistent with the separation at the species level. Furthermore, the taxon *Africonus borgesii* (Trovão, 1979) (Figure 1D, Figure 8C), also known from Boa Vista Island, appears closer to *A. josephinae* (uncorrected p distance of 0.5 %) than *A. angeluquei* sp. nov. The observed differences between *A. angeluquei* sp. nov. and *A. josephinae* in shell and radular morphometric parameters are not statistically significant. In any case, the shell of *A. josephinae* is more pyriform than that of *A. angeluquei* sp. nov., with a more rounded shoulder. The shell of *A. angeluquei* sp. nov. is usually more conical, with straight sides and shoulder often subangulated. Apart from the different area of geographical distribution, both species differ in the ground color of the shell. The shell of *A. angeluquei* sp. nov. is most often white or yellow (Plate 2A-L), although brown and pinkish specimens are also known (Plate 2M). In the case of *A. josephinae*, the situation is reversed, as the most typical specimens are

brown, and yellow specimens are less frequent but not unknown. The recently named species *Africonus guiandradoi* Cossignani & Fiadeiro, 2017 (Figure 1E) from NE Sal Rei, Boa Vista Island, actually applies to such yellow specimens of *A. josephinae*, in this case with some fine brown spiral lines present. Hence, *A. guiandradoi* must be considered a synonym (color form) of *A. josephinae*. The occasional presence of fine dark brown spiral lines is a feature also observed in some specimens of *A. angeluquei* sp. nov. (Plate 2L), as it is the change of coloration of the shell as the species grows (Plate 2K). These features must be considered elements of the variability of the species, and lack any taxonomic value.

DISCUSSION

The taxonomy of cone snails has relied mostly on shell form and coloration (Tucker and Tenorio, 2009). The comparison of these phenotypic features is generally useful when there are conspicuous differences among taxa but shell has been shown to be highly homoplasious in some instances and subjected to diverse evolutionary forces that may confound taxonomic identification (Abalde *et al.* 2017). In some cases, differences in shell coloration and banding patterns among individuals may only reflect phenotypic plasticity and local adaptation (and not true species differences) and on the contrary, in other cases, shells having only subtle differences in coloration and banding patterns may result from convergence and cover cryptic species. To distinguish these problems, the use of robust molecular phylogenies is very helpful. The great diversification of cone snails in the Cabo Verde archipelago, which hosts 10% of cone species diversity worldwide, has attracted the attention of taxonomists, evolutionary biologists, and amateurs alike (Rolán 1990, Monteiro *et al.* 2004, Cunha *et al.* 2005, Duda

& Rolán 2005, Peters *et al.* 2016). To further understand how the extraordinary diversity of cone snails was originated and is maintained in these islands, a first crucial step was revising the taxonomic status of all described species under the light of a robust phylogeny, which was reconstructed based on mitochondrial genomes (Abalde *et al.* 2017). This phylogeny was useful in validating some species, uncovering synonyms, and in some few instances discovering cryptic species. Here, we described two cases belonging to the genera *Kallocomus* and *Africonus*, respectively. Each case represents a striking example of cones with similar morphology, but important mitochondrial sequence divergence, and found in different islands: *A. angeluquei* sp. nov. and *A. josephinae* are in Maio and Boa Vista, respectively whereas *K. marimaris* sp. nov. and *K. venulatus* are in Sal versus Maio and Boa Vista, respectively. Thus far, almost all species within *Africonus* are endemic to an island, which would be in agreement with the species status of *A. angeluquei* sp. nov. (another case of morphological convergence over islands is the recently described *A. freitasi* from São Vicente Island, which is very similar to *Africonus miruchae* from Sal Island; Tenorio *et al.* 2017). Additionally, in both cases, the closest sister group is not the species with the convergent phenotype but a different one: *A. josephinae* is closer to *A. borgesii* than *A. angeluquei* sp. nov., and *K. ateralbus* is closer to *K. marimaris* sp. nov. than *K. venulatus*. Therefore, the two newly described species are best identified with molecular techniques and by their geographic distribution rather than by their subtle shell differences, what should be considered for conservation purposes (Peters *et al.* 2016).

ACKNOWLEDGEMENTS

We are grateful to Carlos M. L. Afonso for assistance during sampling, and for the photos of live specimens. We thank Iderlindo Santos and Sónia Araujo from Direcção Nacional do Meio Ambiente of the Ministério do Ambiente, Habitação e Ordenamento do Território (MAHOT) of the Republic of Cabo Verde for their help with collecting permits (07/2013, 26/2013, 01/2014, 04/2015, and 03/2016). This work was supported by the Spanish Ministry of Science and Innovation, grants CGL2013-45211-C2-2-P and CGL2016-75255-C2-1-P (AEI/FEDER, UE) to RZ; BES-2014-069575 to SA. We are indebted to David Posada and Sara Rocha for the transcriptomic data of the specimens 0639 and 0641 of *K. marimaris* used to obtain the mitochondrial genes representing the Rabo de Junco population.

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Plate 1. *Kalloconus marimaris* sp. nov. A-B. Holotype, 38.6 mm; C. Paratype 1, 37.2 mm; D. Paratype 2, 29.7 mm; E. Paratype 3, 30.9 mm; F. Paratype 4, 31.7 mm; G. Paratype 5, 28.3 mm; H. Paratype 6, 27.3 mm; I. Paratype 7, 40.1 mm; J. Paratype 8, 39.8 mm; K. Paratype 9, 36.6; L. Paratype 10, 40.9 mm; M. Paratype 11, 41.5 mm.



Plate 2. *Africonus angeluquei* sp. nov. A-B. Holotype, 30.0 mm; C. Paratype 1, 21.7 mm; D. Paratype 2, 18.8 mm; E. Paratype 3, 24.8 mm; F. Paratype 4, 28.4 mm; G. Paratype 5, 21.3 mm; H. Paratype 6, 21.7 mm; I. Paratype 7, 37.8 mm; J. Paratype 8, 34.0 mm; K. Paratype 9, 30.0; L. Paratype 10, 20.4 mm; M. Paratype 11, 24.3 mm.

New Gastropods from Namibia, South Australia, and Cuba

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ABSTRACT Three new gastropods are described as potential biogeographical index taxa. These new mollusks include the naticid *Euspira massieri* new species (from Namibia), the muricid *Pterochelus webbi* new species (from the Great Australian Bight, South Australia), and the conid *Jaspidiconus prugnaudorum* new species (from the Jardines de la Reina Archipelago, Cuba). These new index species will be used for defining biogeographical units within their respective oceans and will be incorporated into an upcoming book on worldwide marine molluscan biogeography.

KEY WORDS Gastropods, Naticidae, *Euspira*, Muricidae, *Pterochelus*, Conidae, Conilithinae, *Jaspidiconus*, Namibia, Great Australian Bight, South Australia, Cuba.

INTRODUCTION

The authors, along with co-worker Robert F. Myers, are in the final stages of preparation for a large and comprehensive book on worldwide marine molluscan biogeography ("Illustrated Guide to Marine Molluscan Biogeography: Tropical and Warm Temperate Seas"). While assembling the lists of biogeographical index species that will be illustrated in the book, we found that a number of important taxa were still unnamed. In several previous papers in this series of preparatory works, we described a number of important index taxa in the families Conidae, Volutidae, Fascioliidae, Olividae, Harpidae, and Cypraeidae. Out of the over 1800 species that will be illustrated in the biogeography book, only three remained new to science, including members of the families Naticidae, Muricidae, and Conidae. These important index taxa are described in the following sections. The holotypes of the new species are deposited at three museums: the Los Angeles County Museum of Natural History, Los Angeles, California (with an LACM catalog

number); the South Australian Museum, Adelaide, South Australia (with an SAMA catalog number); and the National Museum of Natural History, Paris, France (with an MNHN IM catalog number).

SYSTEMATICS

Class Gastropoda
 Subclass Orthogastropoda
 Superorder Caenogastropoda
 Order Littorinimorpha
 Infraorder Mesogastropoda
 Superfamily Naticoidea
 Family Naticidae
 Subfamily Polinicinae
 Genus *Euspira* Agassiz, 1838

Euspira massieri new species
 (Figures 1, 4A, 4B)

Description. Shell of average size for genus, thin, globose and inflated, with rounded shoulder and sides; spire slightly elevated, with rounded whorls; subsutural area slightly flattened; umbilicus present, narrow, deeply

perforate; anterior end of umbilicus with single large, prominent raised cord; columellar area with large, prominent, roughly-rectangular parietal shield along posterior one-third of aperture; white parietal shield adherent, extending onto body whorl; anterior two-thirds of parietal shield thin, bladelike, not adherent, with large indented area that exposes entire umbilical opening; edge of indented area with large dark brown stain; aperture wide, flaring, roughly semicircular; shell color dark tan or brown, with pure white anterior end of body whorl and base of shell; interior of umbilicus white or pale tan, with anterior umbilical cord being darker tan; interior of aperture dark tan or brown on posterior area, turning white on anterior area.



Figure 1. *Euspira massieri* Petuch and Berschauer new species

Type Material: Holotype. Length 38.6 mm, width 35.4 mm, 275-300 m depth south of Walvis Bay, Namibia. LACM 3513. **Other Material Examined.** 2 specimens, heights 35 mm and 37 mm, widths 32 mm and 34 mm, from the same depths and locality as the

holotype, in the research collection of the senior author. 2 specimens, heights 32.2 mm and 21.8 mm, widths 30.5 mm and 20.5 mm, from the same depth and locality as the holotype, in the research collection of the junior author.

Type Locality. Trawled by commercial fishing boats from 275-300 m depths south of Walvis Bay, Namibia.

Distribution. At present, known only from the coast of Namibia, from south of Walvis Bay to Luderitz.

Ecology. The new species prefers organic-rich mud sea floors at depths of around 300 m. Here, it occurs along with other Namibian endemic gastropods such as the aporrhaid *Aporrhais pesgallina*, and the volutes *Athleta massieri* and *Athleta easoni*. For more details on the structure of the deep water Namibian ecosystems, see Petuch and Berschauer (2017a and 2017b).

Etymology. Named for Werner Massier of Swakopmund, Namibia, inspired naturalist and well-known shell dealer, who first recognized the species as being new to science.

Discussion. *Euspira massieri* is most similar to the widespread Eastern Atlantic *Euspira fusca* (Blainville, 1825), which ranges from the North Sea (Faroe Islands) south to Angola. The new Namibian endemic species differs from its wide-ranging congener in having a narrower and more laterally-compressed shell outline, in having a proportionally smaller and narrower umbilicus, in having a prominent anterior umbilical cord, and in having the entire anterior end of the body whorl and shell base being pure white. The most conspicuous difference between *E. massieri* and *E. fusca* is seen in the form and structure of the parietal shield along the columellar side of the aperture. In the new species, the parietal shield is proportionally

small and covers only around one-third of the parietal area, and extends onto the body whorl as a large white rectangular callus-like structure at the posterior end of the aperture. In *E. fusca*, the parietal shield is much better developed, extending over two-thirds of the length of the aperture and partially closes off the umbilicus. Although being proportionally larger and better-developed, the parietal shield structure of *E. fusca* does not have a large, adherent callus-like structure at the posterior end of the columellar area. This large white rectangular callus is unique to *E. massieri*.

Infraorder Neogastropoda

Superfamily Muricoidea

Family Muricidae

Subfamily Muricinae

Genus *Pterochelus* Jousseaume, 1880

Pterochelus webbi new species
(Figures 2, 4E, 4F)

Description. shell small for genus, very elongated and slender, thin and delicate; spire high and protracted, almost same length as body whorl; shoulder and subsutural area sloping; body whorl and spire with 3 varices per whorl; siphonal canal elongated and straight, ornamented with 3 narrow, thin, web-like varices, recurved dorsally at anterior tip; body whorl and siphonal canal varices proportionally small and undeveloped, thin and delicate, translucent, frilly, with crenulated edges; posterior ends of body whorl and spire varices with single large, pointed, spine-like blade that projects posteriorly; apertural sides of posterior blades with large open canal, with last varix having direct connection to apertural opening; single large elongated knob present between each pair of varices on body whorl and spire; body whorl ornamented with 3 large spiral cords, with largest corresponding to open canal of large blade; siphonal canal ornamented with

8 thin, small, closely-packed spiral cords; entire surfaces of body whorl, spire, and siphonal canal covered with extremely numerous fine raised frills that correspond to growth increments, giving shell rough, fimbriated, highly-textured appearance; body whorl and siphonal canal color uniform translucent white; single pale tan spot present on each intravarical knob; early whorls and protoconch pale yellow-tan; aperture proportionally large, oval; protoconch large, bulbous, rounded, composed of 2 whorls.



Figure 2. *Pterochelus webbi* Petuch and Berschauer new species

Type Material. Holotype: Length 34.9 mm, width 19.6 mm, from 150 m depth in the Great Australian Bight, South Australia. SAMA D49319. **Other Material Examined:** length 41 mm, width 24 mm, from the same depth and locality as the holotype, in the research collection of the senior author; length 37 mm, width 21 mm, from the same locality and depth as the holotype, in the collection of Adrian Bishop, Yorketown, South Australia.

Type Locality. Dredged by the commercial trawler *Lorna Dorn*, from 150 m depth southwest of Ceduna, South Australia (between East Longitude 130 and 132 degrees), in the Great Australian Bight. The holotype was collected on November 13, 1996.

Distribution. At present, known only from the Great Australian Bight, Australia.

Ecology. This delicate new muricid prefers depths of 150 m, probably on shell rubble sea floors and sponge beds.

Etymology. The taxon honors Captain Neil Webb, captain of the trawler *Lorna Dorn*, who collected the type lot and generously donated the specimens for scientific study.

Discussion. Of the known *Pterochelus* species, *P. webbi* is most similar to the wide-ranging *P. duffusi* Iredale, 1936 (Figure 4 G and H), which occurs from Queensland to Tasmania and South Australia. The new Great Australian Bight species differs from *P. duffusi* in being a much more slender and elongated shell with a straighter siphonal canal, in having proportionally-smaller and less-developed varical wings, in being a less-colorful shell that lacks any brown mottling, and in being a much more sculptured shell that is covered with extremely numerous fine frilly scales. *Pterochelus webbi* is also similar to *P. undosus*

(E. Vokes, 1993) from southern Western Australia, but differs in being a much smaller, more slender, and elongated shell, in having much narrower and less-developed varical wings, and in having a pure white shell color, as opposed to the brown and dark brown-banded shell of *P. undosus*. Webb's Murex is a component of a distinctive and mostly-unexplored malacofauna that occurs in the deeper waters of the Great Australian Bight, from offshore of Eucla, Western Australia to Ceduna, South Australia. Other recent discoveries, from the same depth range and general area as *P. webbi*, include the delicate and elongated fasciolariid *Fusinus bishopi* Petuch and Berschauer, 2017 and the deep water cypraeid *Austrocypraea reevei bishopi* Petuch, Berschauer and Waller, 2017 (see Petuch, Berschauer, and Waller, 2017 for more details on the ecology of the deep water offshore areas of the Great Australian Bight).

Superfamily Conoidea

Family Conidae

Subfamily Conilithinae

Genus *Jaspidiconus* Petuch, 2004

Jaspidiconus prugnaudorum new species
(Figures 3, 4C, 4D)

Description. Shell of average size for genus, cylindrical and fusiform, with elevated, subpyramidal spire; shoulder sharply angled and carinate, edged with 14-16 small rounded pustules; sutures of spire whorls also edged with row of small pustules; body whorl ornamented with 18-20 rows of small pustules, which become progressively smaller and less developed toward anterior end; anterior half of body whorl sculpted with 12 deeply-incised spiral sulci; some individuals (like specimen in collection of senior author) are smoother, with less-developed pustules that are primarily confined to the anterior half of body whorl;

shoulder carina of smoother specimens lacking distinct pustules, having only slight undulations; shell base color bright pink, overlaid with 2 broad bands of large amorphous salmon-orange patches; paler pink band present around body whorl just anterior of mid-body line, separating bands of salmon-orange patches; spire pale pinkish-white with widely-scattered darker pink elongated flammules; small darker pink dots present between pustules on shoulder carina and sutural areas of spire; early whorls and protoconch pale salmon-orange; protoconch proportionally large, bulbous, composed of 2 whorls; aperture narrow, widening slight toward anterior end, bright pink within interior.



Figure 3. *Jaspidiconus prugnaudorum* Petuch and Berschauer new species

Type Material. Holotype: Length 22.2 mm, width 11.0 mm, from Cayo Anclitas, Jardines de la Reina Archipelago, Cuba. MNHN IM-2000-338883. **Other Material Examined:** length 21 mm, width 11 mm, from the same locality and depth as the holotype, in the research collection of the senior author; length 21 mm, from the same locality and depth as the holotype, in the collection of Fabrice Prugnaud, Tours, France.

Type Locality. The new cone was collected at night, 10 m depth on a muddy carbonate sand sea floor, off Cayo Anclitas, Jardines de la Reina Archipelago, Camaguey Province, southeastern coast of Cuba.

Distribution. At present, known only from the Jardines de la Reina Archipelago, off southeastern Cuba, and the new species is probably endemic to this isolated group of islands.

Ecology. The new Jardines de la Reina endemic species prefers open muddy carbonate sand sea floors in 10 m depths.

Etymology. Named for Fabrice Prugnaud of Tours, France, his father Alain Prugnaud, and his brother Bruno Prugnaud, who, together, made shell collecting a family passion and who kindly donated the type specimens of the new Cuban cone.

Discussion. Of the known Caribbean *Jaspidiconus* species, *J. prugnaudorum* most closely resembles, in both size and shape, *J. boriqwa* Petuch, Berschauer, and Poremski, 2016 from Puerto Rico. The new Cuban species differs from its Puerto Rican congener in having a bright orange and salmon shell color, in having rows of small pustules on the body whorl, shoulder, and spire, and in lacking the purple and brown base color and large dark brown flammules that are characteristic of *J.*

boriqua. The new species is also similar to *J. culebranus* Petuch, Berschauer, and Poremski, 2016 from Culebra Island (between Puerto Rico and St. Thomas) but differs in being a much more colorful shell (bright pink and salmon in *J. prugnaudorum* as opposed to uniformly pure white or pale yellow white in *J. culebranus*) and in being a more sculptured shell, with rows of small pustules and deeply-incised spiral sulci (see Petuch, Berschauer, and Poremski, 2016 for illustrations and discussions of the Puerto Rican and Culebran endemic cones). At present, *J. prugnaudorum* has been collected only on Cayo Anclitas, but is probably present on all of the islands of the isolated Jardines de la Reina Archipelago.

ACNOWLEDGMENTS

For the generous donation of study material and holotypes, we thank the following: Werner Massier, Swakopmund, Namibia (for specimens of *Euspira massieri*); Adrian Bishop, Yorketown, South Australia and Captain Neil Webb, skipper of the *Lorna Dorn* (for specimens of *Pterochelus webbi*); and Fabrice

Prugnaud, Tours, France (for specimens of *Jaspidiconus prugnaudorum*). Special thanks goes to Roland Houart, Landen, Belgium for the photos of *Pterochelus duffusi* used in this paper.

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Figure 4. A, B = *Euspira massieri* Petuch and Berschauer new species - holotype 32.2 mm in length; C, D = *Jaspidiconus prugnaudorum* Petuch and Berschauer new species - holotype 22.2 mm in length; E, F = *Pterochelus webbi* Petuch and Berschauer new species - holotype 34.9 mm in length; G, H = *P. duffusi* Iredale, 1936 - trawled off Cape Morton, Queensland, Australia, 35.1 mm in length (images courtesy of Roland Houart).

The description of two new species: *Marginella (Nataliamarginella) sagena* and *Marginella everriculum* from the Tugela Bank, South Africa

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ABSTRACT Two new species from the Tugela Sub-Province (Tugela Bank) are described: *Marginella sagena* new species and *M. everriculum* new species. The two new species are compared to *Marginella monicae*, *M. tuguriana*, *M. joostei*, *M. natalcinerea*, *M. westhuizeni* and *M. gabrielae*.

KEYWORDS *Marginella*, *Nataliamarginella*, Tugela Sub-Province, KwaZulu-Natal Province, South Africa, *everriculum*, *gabrielae*, *joostei*, *monicae*, *natalcinerea*, *sagena*, *tuguriana*, *westhuizeni*.

INTRODUCTION

In the recent in the past, several species of *Marginella* were trawled from depths of 100-375 m along the KwaZulu-Natal coast, South Africa and off southern Mozambique. These all have similar morphological shell characteristics. In the southern part of the Mozambique Province (ranging from Inhaca Island to Lumbo Island, see Figure 1), *Marginella gabrielae* Bozzetti, 1998 is dredged and trawled at depths of 80-120 m off the coast of Inhambane and just south of Inhambane at Quissico and Zavora. (Veldsman, S. 2017). Paratype 3 of *M. gabrielae* is illustrated in Plate 2.7, and the holotype can be viewed in Cossignani (2006).

Farther south, two more species within this group are found in the Northern KwaZulu-Natal Sub-Province, KwaZulu-Natal Province. The Northern KwaZulu-Natal Sub-Province stretches from South of Maputo (Inhaca Island) to Mfolozi River just south of St. Lucia (Figure 1) (Veldsman, S. 2017). Species within the subgenus *Nataliamarginella* from the Northern KwaZulu-Natal Sub-Province are: *Marginella tuguriana* Lussi, 1993 (trawled at depths of 200-375 m) and *Marginella monicae* Bozzetti, 1997 (trawled at depths of 90-200 m). The holotype

of *Marginella monicae* was acquired off the coast of Maputo, trawled at 90 m and can be viewed in Cossignani (2006).

Farther south, the Tugela Bank is found along the coast of KwaZulu-Natal and is classified as the Tugela Sub-Province, with the northern boundary at the Mfolozi River Mouth, south of St. Lucia and the southern boundary at Durban (Figure 1) (Veldsman, S. 2017). Species within the subgenus *Nataliamarginella* that occur in the Tugela Sub-Province are: *Marginella westhuizeni* Massier, 1993, *M. joostei* Liltved & Millard, 1994 and *M. natalcinerea* Massier, 1993 along with several unnamed species, of which two are described here as new species: *Marginella sagena* new species, and *M. everriculum* new species. The holotype of *M. joostei* is illustrated in Plate 2.1 and paratype 1 in Plate 3.3. The holotype of *Marginella dawnae* described by Liltved & Millard (1994), was found to be the same as *M. natalcinerea* Massier, 1993 (holotype is illustrated in Plate 1.6), thus become a junior synonym of *M. natalcinerea*. Paratype 1 of *Marginella dawnae* Liltved & Millard, 1994 (Plate 1.2) is in fact a *Marginella tuguriana* (the holotype is illustrated in Plate 1.2), and Paratype 1 of *Marginella dawnae* was found further north from the

Northern KwaZulu-Natal Sub-Province. The holotype of *Marginella asra*, described by Liltved & Millard (1994) (Plate 3.2), was found to be the same as *M. westhuizeni* Massier, 1993,

thus become a junior synonym of *M. westhuizeni* (the holotype of *M. westhuizeni* is illustrated in Plate 3.1).

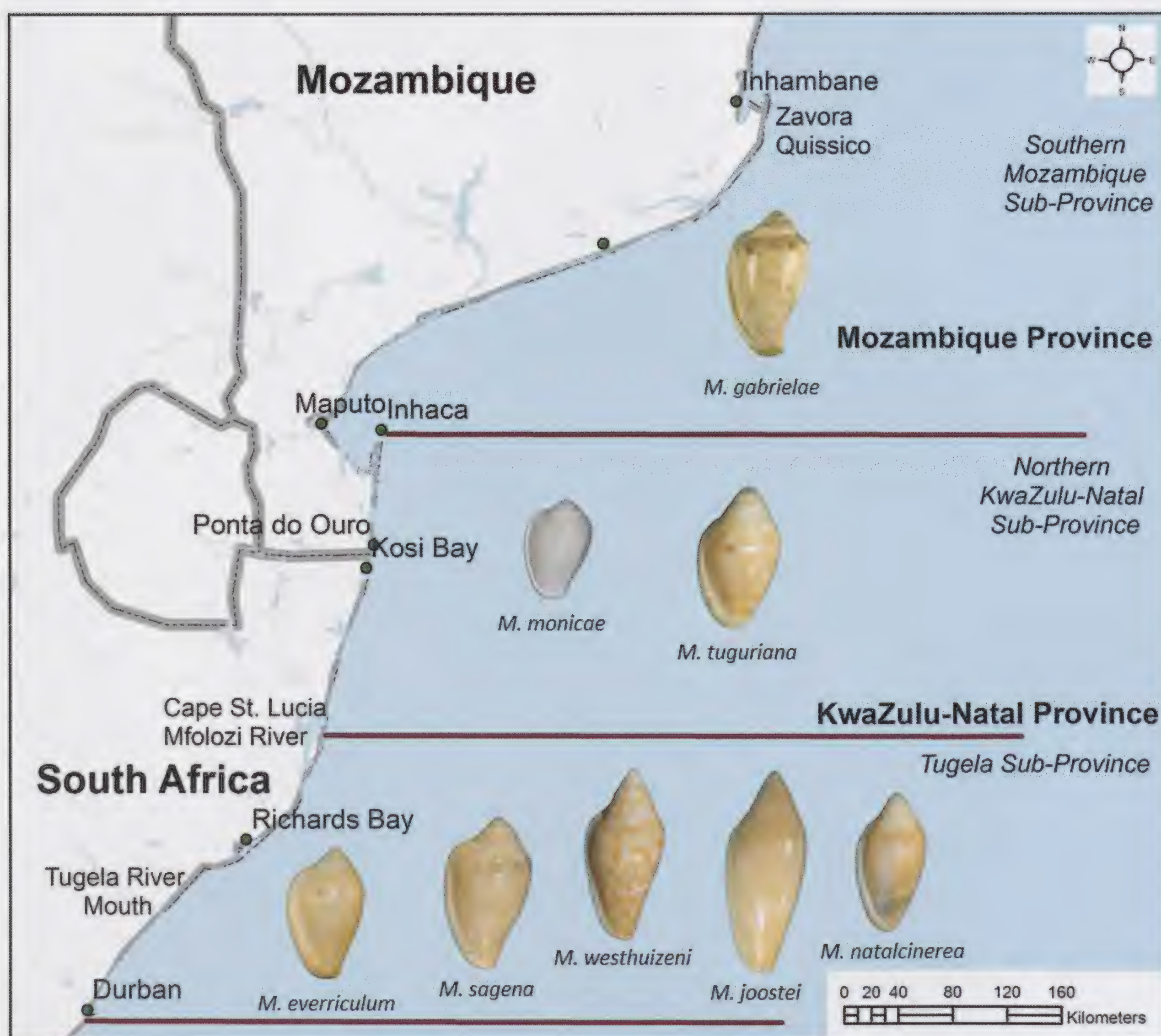


Figure 1. Illustration of the eight species discussed according to their coastal Sub-Province occurrence (Altered after Veldsman, S. 2017).

SYSTEMATICS

Family: Marginellidae Flemming, 1828

Genus: *Marginella* Lamarck, 1799

Subgenus: *Nataliamarginella* S.Veldsman, 2017

Marginella (Nataliamarginella) sagena
S..Veldsman, new species

Description:

The shell is large in size (average of 22 mm), light-weight and bulbous sub-pyriform-biconical in shape with a very broad, rounded shoulder. Shell surface smooth, spire low in height (14% on average), wide protoconch. No labial denticles or a posterior labial notch. Columella, with four continuous plications wide apart, the lower (fourth) plica ending at base of shell. Callus covering all the plicae. Aperture very wide, off-white on inside. Thin lip, off-white in colouration, with no markings on the labrum. Apex off-white, spire light cream with few small dark brown to black markings. Background colour of the body whorl is cream with dark brown to black markings near shoulder. There are weak markings visible further below around the body-whorl, especially towards the lower end.

The Holotype of *M. sagena* new species is illustrated in Plate 1.3, which has been donated to the Natal Museum, South Africa (NMSA), Holotype ID Number: P1003/T4225.

Type and distribution:

Type locality of the Holotype of *M. sagena* new species is off Tugela Bank, east of Tugela River (approximately 29°19.1'S & 31°57.5'E), Tugela Sub-Province, KwaZulu-Natal Province, South Africa, trawled 200-300 m, on soft mud.

Specimens can be found from depths of 200-300 m. The species distribution range is limited to the Tugela Bank, Tugela Sub-Province (Figure 1).

The physical measurements of the Holotype of *M. sagena* new species, and five Paratypes are summarized below:

- | | |
|-------------|--|
| Holotype: | 23.46 x 13.45 mm (Plate 1.3);
Tugela Bank, east of Tugela River (approximately 29°19.1'S & 31°57.5'E), Tugela Sub-Province; Trawled 200-300 m, on soft mud; Coll. Natal Museum South Africa (NMSA), ID No: P1003/T4225. Donated by S.G. Veldsman. |
| Paratype 1: | 25.00 x 14.05 mm (Plate 5.1);
Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |
| Paratype 2: | 23.05 x 11.01 mm (Plate 5.2);
Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |
| Paratype 3: | 20.91 x 11.07 mm (Plate 5.3);
Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |
| Paratype 4: | 19.44 x 10.54 mm (Plate 5.4);
Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |
| Paratype 5: | 20.64 x 10.98 mm (Plate 5.5);
Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |

Marginella (Nataliamarginella) everriculum
S. Veldsman, new species

Description:

The shell is large in size (average of 19 mm), heavy and ovate-biconical in shape with a broad, rounded shoulder. Shell surface smooth, spire low in height (15% on average), wide protoconch. No labial denticles or a posterior labial notch. Columella, with four continuous plications relatively wide apart, the lower (fourth) plica ending at base of shell. Callus covering all the plicae. Aperture narrow, off-white to light cream on inside. Very thick lip, off-white to light cream in colouration, with no markings on the labrum. Apex off-white, spire light cream with no markings. Background colour of the body whorl is cream with dark brown to black spots near shoulder. A thin line consisting of dark brown to black spots are occasionally visible around the lower third area of the shell.

The Holotype of *M. everriculum* new species, is illustrated in Plate 1.1, which has been donated to the Natal Museum, South Africa (NMSA), Holotype ID Number: P1004/T4226.

Type and distribution:

Type locality of the Holotype of *M. everriculum* new species is off the Tugela Bank, east of Tugela River (approximately 29°19.1'S & 31°57.5'E), Tugela Sub-Province, KwaZulu-Natal Province, South Africa, trawled 200-300 m, on soft mud.

Specimens can be found from depths of 200-300 m. The species distribution range is limited to the Tugela Bank, Tugela Sub-Province (Figure 1).

The physical measurements of the Holotype of *M. everriculum* new species, and 16 Paratypes are summarized below:

- | | |
|-------------|---|
| Holotype: | 18.66 x 11.35 mm (Plate 1.1); Tugela Bank, east of Tugela River (approximately 29°19.1'S & 31°57.5'E), Tugela Sub-Province; Trawled 200-300 m, on soft mud; Coll. Natal Museum South Africa (NMSA), ID No: P1004/T4226. Donated by S.G. Veldsman. |
| Paratype 1: | 21.11 x 12.12 mm (Plate 6.1); Tugela Bank, east of Tugela River, Tugela Sub-Province; Trawled 200-300 m; Veldsman Collection. |
| Paratype 2: | 21.53 x 12.55 mm (Plate 6.2); Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |
| Paratype 3: | 17.87 x 10.23 mm; Tugela Bank, east of Tugela River, Tugela Sub-Province; Trawled 200-300 m; Veldsman Collection. |
| Paratype 4: | 20.06 x 12.87 mm (Plate 2.3); Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |
| Paratype 5: | 17.04 x 10.78 mm; Tugela Bank, east of Tugela River, Tugela Sub-Province; Trawled 200-300m; Veldsman Collection. |
| Paratype 6: | 19.07 x 11.28 mm (Plate 6.3); Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |
| Paratype 7: | 20.15 x 11.74 mm; Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection. |

- Paratype 8: 19.45 x 12.05 mm; Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Veldsman Collection.
- Paratype 9: 20.45 x 12.94 mm; Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection.
- Paratype 10: 20.22 x 12.24 mm; Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection.
- Paratype 11: 19.03 x 12.21 mm; Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection.
- Paratype 12: 20.90 x 11.97 mm (Plate 6.4); Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection.
- Paratype 13: 18.52 x 10.91 mm (Plate 6.5); Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection.
- Paratype 14: 19.07 x 11.33 mm; Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection.
- Paratype 15: 20.85 x 12.41 mm (Plate 6.6); Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; Aiken Collection.
- Paratype 16: 19.49 x 11.23 mm (Plate 2.4); Tugela Bank, east of Durban, Tugela Sub-Province; Trawled 200-300 m; A. Potgieter Collection.

DISCUSSION

All of the species discussed have a smooth shell surface, no labial denticles or a posterior labial notch. All of them have four continuous plications relatively wide apart, the lower (fourth) plica ending at base of shell, with callus covering all the plicae. The average size, general shape, spire, aperture width, lip thickness and body-whorl colouration differs. The main differences are discussed in Table 1 and Table 2. All comparisons are made with relation to each other and not meant to be a measure between *Marginella* species not discussed in this article.

Etymology:

Both the two species were trawled by typical large dragnets, hence the names *everriculum* and *sagena* that refer to dragnets.

	<i>M. sagera</i> new sp.	<i>M. gabrielae</i>	<i>M. monicae</i>	<i>M. westhuizeni</i>
Average size	22 mm	18 mm	13 mm	25 mm
General shape	Bulbous sub-pyriform-biconical; very broad, rounded shoulder.	Sub-pyriform-biconical; very broad shoulder.	Ovate-biconical; broad rounded shoulder.	Elongated biconical; narrow, angular rounded shoulder.
Spire	Spire low in height (14% on average), smooth to slightly stepped.	Spire low in height (14% on average), stepped. Light cream with zig-zag dark brown to black markings.	Spire low in height (14% on average), smooth. Light cream with thin light to dark brown markings.	Spire moderately high (22% on average), stepped. Light cream with orange to brown thick flame-like pattern.
Aperture	Very wide.	Wide.	Narrow.	Moderately wide.
Lip	Very thin lip.	Moderately thick lip.	Very thick lip.	Moderately thick lip.
Body-whorl	Background colour is cream with dark brown to black markings near shoulder. There are weak markings visible further below around the body-whorl, especially towards the lower end.	Background colour is cream with dark brown to black zig-zag markings across shell. Finer weak markings are visible further below around the body-whorl, especially towards the lower end.	Background colour is cream to light yellow with a broken light brown band on lower third of shell near the base.	Background colour is off-white to light cream with a thick orange to brown flame-like pattern, a light coloured band on shoulder and around middle, encircling the body-whorl.

Table 1. Discussion of main differences of *Marginella sagera*, *M. gabrielae*, *M. monicae* and *M. westhuizeni*.

	<i>M. everriculum</i> new sp.	<i>M. tuguriana</i>	<i>M. natalcinerea</i>	<i>M. joostei</i>
Average size	19 mm	15 mm	18 mm	28 mm
General shape	Ovate-biconical; broad rounded shoulder.	Ovate; broad rounded shoulder.	Elongated ovate-biconical; narrow, angular rounded shoulder.	Elongated ovate-biconical; narrow, angular rounded shoulder.
Spire	Spire low in height (15% on average), smooth.	Spire high (27% on average, smooth. Light cream with light to dark brown markings.	Spire moderately high (24% on average), smooth. Light cream with no markings.	Spire moderately high (22% on average), smooth. Light cream with orange to light brown thick line present.
Aperture	Narrow.	Narrow.	Narrow.	Narrow.
Lip	Very thick lip.	Very thick lip.	Very thick lip.	Moderately thick lip.
Body-whorl	Background colour is cream with dark brown to black spots near shoulder. In some shells a thin line consisting of dark brown to black spots are visible around the lower third area of the shell.	Background colour is cream with light brown bands separated by dark brown lines around the body whorl. A thicker dark brown band is visible on lower third of shell near the base.	Background colour is dark cream with light brown bands separated by dark brown lines around the body whorl. A thicker dark brown band is visible on lower third of shell near the base.	Background colour is dark cream with a thick orange to light brown band on shoulder and a thicker dark orange to light brown band on lower third of shell near the base.

Table 2. Discussion of main differences of *Marginella everriculum*, *M. tuguriana*, *M. natalcinerea* and *M. joostei*.

ACKNOWLEDGEMENTS

Special acknowledgement to Roy Aiken who supplied many of the research material used to describe the new species. The author further acknowledges: Linda Davis, Collections Manager, Mollusca at the Natal Museum, Pietermaritzburg for supplying the new holotype numbers; Vellies Veldsman for proof reading and input into the article; and Albe Bosman, Collections Manager, Ichthyology, Natural History, Iziko Museums of South Africa for photographing the Holotype of *Marginella joostei*.

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Plate 1. Figures: **1.** *Marginella everriculum* new species (18.66 x 11.35 mm) - Holotype; Tugela Bank, east of Tugela River, trawled 200-300 m; Coll. NMSA, ID No: P1004/T4226. **2.** *Marginella tuguriana* Lussi, 1993 (ex. *M. dawnae* Liltved & Millard, 1994 - Paratype 1) (15.34 x 8.57 mm); Off Inhaca, trawled 175 m; Coll. NMSA, ID No: K1868/T185. **3.** *Marginella sagena* new species (23.46 x 13.45 mm) - Holotype; Tugela Bank, east of Tugela River, trawled 200-300 m; Coll. NMSA, ID No: P1003/T4225. **4.** *Marginella monicae* Bozzetti, 1997 (10.18 x 6.88 mm); Cape Vidal, trawled 200 m; Coll. NMSA, ID No: E3949. **5.** *Marginella gabriellae* Bozzetti, 1998 (19.40 x 11.30 mm); Quissico, trawled 120 m; photo courtesy of Conchology Inc. **6.** *Marginella natalcinerea* Massier, 1993 (19.40 x 9.36 mm) - Holotype; Off Durban, Tugela Bank, trawled; Coll. NMSA, ID No: V798/T1309.



Plate 2. Figures: **1.** *Marginella joostei* Liltved & Millard, 1994 (28.70 x 11.80mm) - Holotype; East of Durban "The Gate", Tugela Bank, trawled at 300 m; Coll. SAM, ID No: A37575. **2.** *Marginella tuguriana* Lussi, 1993 (17.90 x 9.50 mm); South of Inhaca Island, trawled 375 m; photo courtesy of Conchology Inc. **3.** *Marginella everriculum* new species (20.06 x 12.87 mm) - Paratype 4; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **4.** *Marginella everriculum* new species (19.49 x 11.23 mm) - Paratype 16; Tugela Bank, east of Durban, trawled at 200-300 m; A. Potgieter Collection. **5.** *Marginella tuguriana* Lussi, 1993 (18.64 x 10.99 mm); Southern Mozambique, trawled 250 m; NMSA, ID No: K7356. **6.** *Marginella gabrielae* Bozzetti, 1998 (18.20 x 10.95 mm); Xai-Xai, trawled 100-120 m; Veldsman Collection. **7.** *Marginella gabrielae* Bozzetti, 1998 (18.20 x 10.95 mm) - Paratype 3; south of Zavora, Ponta Mazanza, trawled 90-118 m; NMSA, ID No: L5065/T1743.



Plate 3. Figures: **1.** *Marginella westhuizeni* Massier, 1993 (23.78 x 11.12 mm) - Holotype; East of Durban "The Gate", Tugela Bank, probably trawled at 550 m; Coll. NMSA, ID No: V797/T1308. **2.** *Marginella westhuizeni* Massier, 1993 (ex. *M. asra* Liltved & Millard, 1994 - Holotype) (21.91 x 10.42 mm); East of Durban "The Gate", Tugela Bank, probably trawled at 550 m; Coll. NMSA, ID No: B6306/T186. **3.** *Marginella joostei* Liltved & Millard, 1994 (35.25 x 14.26 mm) - Paratype 1; East of Durban "The Gate", Tugela Bank, trawled at 300 m; Coll. NMSA, ID No: E7214/T187. **4.** *Marginella westhuizeni* Massier, 1993 (23.57 x 9.73 mm); Tugela Bank, trawled; R. Aiken Collection.



Plate 4. Figures: **1.** *Marginella joostei* Liltved & Millard, 1994 (29.50 x 12.73 mm); Neill Peak, Tugela Bank, trawled at 320-340 m; Coll. NMSA, ID No: E3999. **2.** *Marginella joostei* Liltved & Millard, 1994 (41.01 x 15.04 mm); Tugela Bank, trawled; R. Aiken Collection. **3.** *Marginella joostei* Liltved & Millard, 1994 (22.75 x 9.66 mm); Tugela Bank, trawled; Veldsman Collection. **4.** *Marginella natalcinerea* Massier, 1993 (17.11 x 8.51 mm); Tugela Bank, trawled; Veldsman Collection. **5.** *Marginella natalcinerea* Massier, 1993 (17.18 x 8.92 mm); Tugela Bank, trawled; Veldsman Collection. **6.** *Marginella natalcinerea* Massier, 1993 (15.06 x 7.74 mm); Tugela Bank, trawled; Veldsman Collection. **7.** *Marginella natalcinerea* Massier, 1993 (18.21 x 8.19 mm); Tugela Bank, trawled; Veldsman Collection.



Plate 5. Figures: **1.** *Marginella sagena* new species (25.00 x 14.05 mm) - Paratype 1; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **2.** *Marginella sagena* new species (23.05 x 11.01 mm) - Paratype 2; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **3.** *Marginella sagena* new species (20.91 x 11.07 mm) - Paratype 3; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **4.** *Marginella sagena* new species (19.44 x 10.54 mm) - Paratype 4; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **5.** *Marginella sagena* new species (20.64 x 10.98 mm) - Paratype 5; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection.



Plate 6. Figures: **1.** *Marginella everriculum* new species (21.11 x 12.12 mm) - Paratype 1; Tugela Bank, east of Tugela River, trawled at 200-300 m; Veldsman Collection. **2.** *Marginella everriculum* new species (21.53 x 12.55 mm) - Paratype 2; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **3.** *Marginella everriculum* new species (19.07 x 11.28 mm) - Paratype 6; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **4.** *Marginella everriculum* new species (20.90 x 11.97 mm) - Paratype 12; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **5.** *Marginella everriculum* new species (18.52 x 10.91 mm) - Paratype 13; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection. **6.** *Marginella everriculum* new species (20.85 x 12.41 mm) - Paratype 15; Tugela Bank, east of Durban, trawled at 200-300 m; Aiken Collection.

Discovery of *Myxostoma petiverianum* Wood, 1828 (Gastropoda: Caenogastropoda: Cyclophoroidea: Cyclophoridae) on Hòn Cau, Vietnam

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ABSTRACT The land snail *Myxostoma petiverianum* is previously known from only a few localities in Cambodia and Vietnam. We report on a new record of *Myxostoma petiverianum* from Hòn Cau, an island in the Côn Đảo Archipelago, south-eastern Vietnam.

KEYWORDS *Myxostoma petiverianum*, Vietnam, Hòn Cau, Côn Đảo Archipelago.

INTRODUCTION

The species *Myxostoma petiverianum* Wood, 1828 is until recently, one of the lesser known land snails of Southeast Asia. A flurry of scientific attention on the land snails of southern Vietnam and neighbouring areas in recent years have led to renewed malacological attention on *M. petiverianum*. Egorov (2016) recorded and described the shell and radula morphology of *M. petiverianum* from Kep National Park in Cambodia and Côn Sơn in Vietnam while Foon (2016) described a new subspecies *Myxostoma petiverianum tenggolensis* Foon, 2016 from Peninsular Malaysia (for nomenclatural emendation, see Bouchet, 2016). Nguyễn and Nguyễn (2016) reported the presence of *M. petiverianum* (under the name *Cyclotus fasciatus* Martens, 1864) from Hòn Tre, An Sơn and Lại Sơn islands off the coast of Rạch Giá, south-western Vietnam. Raheem *et al.* (2017) included a photographed specimen of *M. petiverianum* in their pictorial guide to Vietnamese land snails.

In the midst of these publications, a picture of a snail photographed by the first author in 2014 on Hòn Cau, Vietnam and uploaded onto an internet-based citizen science platform was spotted by the third author. Communication was initiated between the authors and it was confirmed that the photographed snail was indeed *M. petiverianum* based on conchological and anatomical comparisons with museum collection specimens and literature. The discovery of *M. petiverianum* on Hòn Cau, Côn Đảo Archipelago is herein reported for permanent scientific record.

Observation and identification of *Myxostoma petiverianum* on Hòn Cau, Vietnam

During the citizen science project titled “Con Dao Land and Sea” organised under the Biodiversity PEEK program, the first and second authors were exploring the rainforests of Hòn Cau (8°41.337'N, 106°44.266'E), Côn Đảo Archipelago, Vietnam when they came across an unidentified land snail on August 3, 2014. This unidentified land snail was photographed

(Figure 1) and submitted to the citizen science platform iNaturalist (www.inaturalist.org). This photograph was later examined by the third author and cross-checked with descriptions in literature and museum collection lots (see Foon, 2016). Note that Hòn Cau is a satellite island of Côn Sơn [= Pulo Condore] (Figure 2), the latter of which is the most well-known locality of *M. petiverianum* based on historical and museum records (Egorov 2016, Foon 2016).

There are many discernible characters in the photographed individual which identify it as *Myxostoma petiverianum*. First, the operculum is thick, horny, has a periphery adorned with somewhat loosely overlapping brown lamellae at the exterior and a raised interior where the columellar muscle is attached to. Second, the shell has a peripheral dark brown band set against a light brown base as well as a peristome that is dark brown, thickened and reflected. Also, the aperture is orientated ventrally and obliquely with respect to the coiling axis. Third, the living animal colour, fine blackish-greyish mottling as well as the genital groove match that of the living sub-adult illustrated in Plate 1, Figure G in Egorov (2016).

Besides these, historical records of land snails from Côn Đảo archipelago (Martens, 1872) suggest no species are closely-related to *Myxostoma petiverianum* except *Cyclophorus volvulus* Müller, 1774. Yet, *Cyclophorus volvulus* can be easily distinguished from *M. petiverianum* by its shell, which has much thicker, dark brown spiral band below the periphery, an aperture that is orientated somewhat parallel to the coiling axis and a rather tall spire with sharp apex (Pfeiffer, 1846), none of which characterises the *M. petiverianum* individual in Figure 1.



Figure 1. Photograph of a living adult *Myxostoma petiverianum*, taken on Hòn Cau, Vietnam. (Photograph by: Scott J. Trageser)

DISCUSSION

This is the first photograph taken of a live adult *Myxostoma petiverianum* (Figure 1). This new locality record is a range extension, which taken together with all known records of *M. petiverianum* in the literature (Egorov, 2016, Foon, 2016, Nguyễn & Nguyễn, 2016), suggests that the species has a distribution limited to the islands and hills of the Mekong Delta region (Figure 2).

The discovery and identification of this land snail via citizen science demonstrates the usefulness of citizen science initiatives in addressing knowledge gaps in under-explored regions with potentially high biodiversity.

ACKNOWLEDGEMENTS

The first and second authors would like express their gratitude to the People's Committee of Bà Rịa-Vũng Tàu Province and the Management Board of Côn Đảo National Park for permission to visit Hòn Cau and to Con Dao Scuba Diving Center for their gracious hospitality and expert guiding services. The third author would like to thank Dinarzarde Raheem (Natural History Museum, London) for providing a copy of the

Raheem *et al.* (2017) illustrated guide and discussions on *Myxostoma petiverianum* specimens in the NHM collection. All authors also thank the reviewers for their constructive comments on the manuscript.

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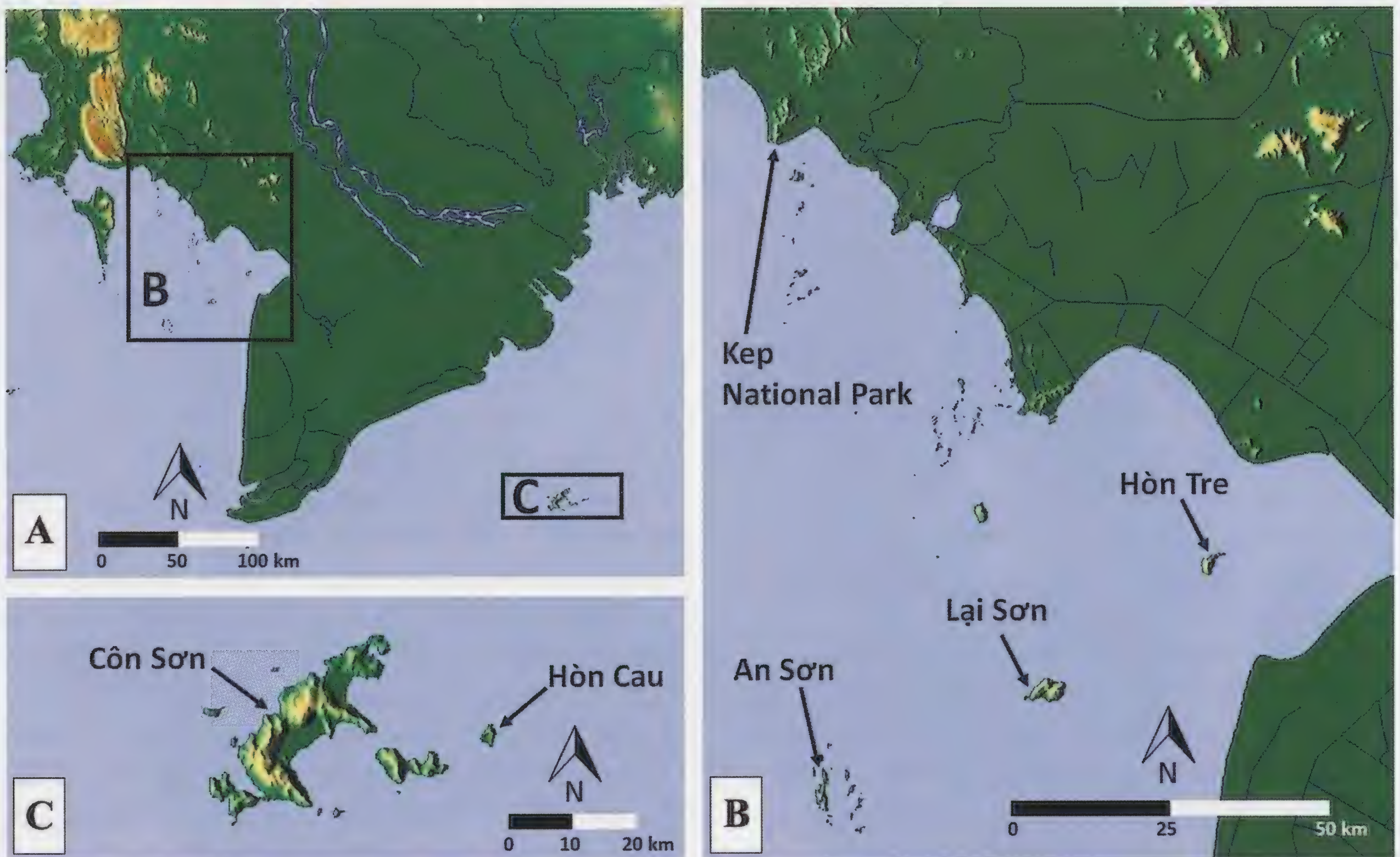


Figure 2. Maps showing known localities of *Myxostoma petiverianum* in the literature (Egorov, 2016, Foon, 2016, Nguyễn & Nguyễn, 2016) as well as records from this study. A. Overview of the Mekong Delta, with boxes indicating areas zoomed in for figures B and C. B. Localities with *M. petiverianum* in the Côn Đảo archipelago. C. Localities with *M. petiverianum* at south-western Vietnam and Cambodia. Relief basemap by Hans Braxmeier (maps-for-free.com).



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New range data for five Trochiform gastropods (Seguensiida & Trochida) from Alaska

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ABSTRACT New range data is presented for four species of Vestigastropods from Alaska. *Bathybembix bairdii* (Dall, 1889) is confirmed from Alaska for the first time.

KEY WORDS Eucyclidae, Calliostomatidae, *Calliostoma*, *Bathybembix*, *Cidarina*, Alaska.

INTRODUCTION

The off-shore waters of Alaska are rarely sampled, and the mollusk fauna is poorly known. Resource assessment trawl surveys in Alaska by the National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center have brought to light numerous new distribution records for marine mollusks. Records for five species in the orders Seguenziida and Trochida are reported upon herein.

McLean, 1996 placed *Bathybembix bairdii* (Dall, 1889) and *Cidarina cidaris* (Carpenter, 1864) in the family Trochidae Rafinesque, 1815, subfamily Calliotropinae. Bouchet, *et. al.*, 2017 transferred these to the family Eucyclidae Koken, 1896, in the order Seguenziida.

NMFS station data is as follows, first two or three numbers refer to the vessel, the next six numbers are the year and cruise number, and the last numbers are the station number. All specimens are in the R.N. Clark collection. Vouchers to be deposited at the Santa Barbara Museum of Natural History (SNMNH), and the Los Angeles County Museum of Natural History (LACM).

Family: Eucyclidae Koken, 1896

***Bathybembix bairdii* (Dall, 1889)**, previously reported from Isla Cedros Baja California, Sur, Mexico (28°) to the Queen Charlotte Islands, British Columbia, Canada (54°) (McLean, 1996).

New records: Gulf of Alaska, W of Noyes Island, Alaska (55°44.77 N, 135°24.55W) (NMFS 134-200501-223), 712 m on mud. Bottom Temperature 3.7°. (*leg.* Duane E. Stevensen, R/V Ocean Explorer, 11 July, 2005). Three specimens: 34.6-37.8 mm. (Figure 1 A).

Gulf of Alaska, W of Noyes Island, Alaska (55°44.76N, 135°21.79) (NMFS 143-201701-289), 671 m on mud. Bottom Temperature 4°C. (*leg.* NMFS, R/V Sea Storm, 2 August, 2017). Two specimens: 32.8 mm and 35.5 mm.

These new records extend the known distribution of *Bathybembix bairdii* 160 km to the North.

***Cidarina cidaris* (Carpenter, 1864)**, previously reported from Isla Cedros, Baja California Sur, Mexico (28°N) to Prince William Sound, Alaska (60°N) (McLean, 1996).

New record: Gulf of Alaska, South of Alaska Peninsula (55°36.81N, 159°11.82 W) (NMFS 159-200901-60), 107 m on mud/stones. Bottom Temperature 2.9°C. (*leg.* R.N. Clark, R/V Pacific Explorer, 8 June, 2009). Six specimens: 32.5-40.6 mm. (Figure 1 B).

This new record extends the known distribution of *Cidarina cidaris* approximately 1,000 km to the Southwest.

Family: Calliostomatidae Thiele, 1924

Calliostoma platinum Dall, 1890, previously reported from San Diego, California (33°N), to Moresby Island, Queen Charlotte Islands, British Columbia, Canada (53°N) (McLean, 1996).

New records: Gulf of Alaska, SE of Forrester Island (54°38.46 N, 133°15.66 W), 371 m. Bottom Temperature 5.5°C (NMFS 143-201701-307) (*leg.* NMFS R/V Sea Storm, 6 August, 2017). One specimen: 25.1 mm.

Remarks: This is an unusual specimen with prominent spiral lirae. (may represent an undescribed species). (Figure 1 D).

Southeastern Alaska, Prince of Wales Island, Cholmondeley Sound, West arm (55°15 N, 132°20 W) (*leg.* Carmelita Zwick, November, 1990). One specimen: 30.7 mm.

Gulf of Alaska, South of Icy Bay (59°17.61 N, 141°56.04 W) (NMFS 100-199601-231), 231 m on gravel. Bottom Temperature 5.2°C. (*leg.* R. N. Clark, F/V Golden Dawn, 18 July, 1996). Two specimens: 18.5 mm (LACM152739) and 34.31 mm (RNC) (Figure 1 C).

These new records extend the known distribution of *Calliostoma platinum* approximately 1,000 km to the North.

Calliostoma annulatum (Lightfoot 1786), previously reported from Isla San Jerónimo, Baja California, Mexico (29°50 N), to Forrester Island, Alaska (55°N) (McLean, 1978).

New record:

Gulf of Alaska, East of Afognak Island (58°18.13 N, 151°09.93 W) (94-200101-221), 86 m on rocks/gravel. Bottom Temperature 6.8°C. (*leg.* R.N. Clark, 11 July, 2001). Two juvenile specimens 14.0 and 14.2 mm. (Figure 1 E).

This new record extends the known distribution of *Calliostoma annulatum* approximately 1,200 km to the Northwest.

Calliostoma variegatum Carpenter, 1864, previously reported from Isla Cedros, Baja California Sur, Mexico (28°N) to Forrester Island, Alaska (55°N) (McLean, 1996).

New record: Gulf of Alaska, East of Afognak Island (58°18.13 N, 151°09.93 W) (94-200101-221), 86 m on rocks/gravel. Bottom Temperature 6.8°C. (*leg.* R.N. Clark, 11 July, 2001). Three juvenile specimens 9.8 to 12.6 mm. (Figure 1 F).

This new record extends the known distribution of *Calliostoma variegatum* approximately 1,200 km to the Northwest.

ACKNOWLEDGEMENTS

I am indebted to Dr. James W. Orr, Robert R Lauth of the Alaska Fisheries Science Center, and David P. Berschauer for comments on the text.

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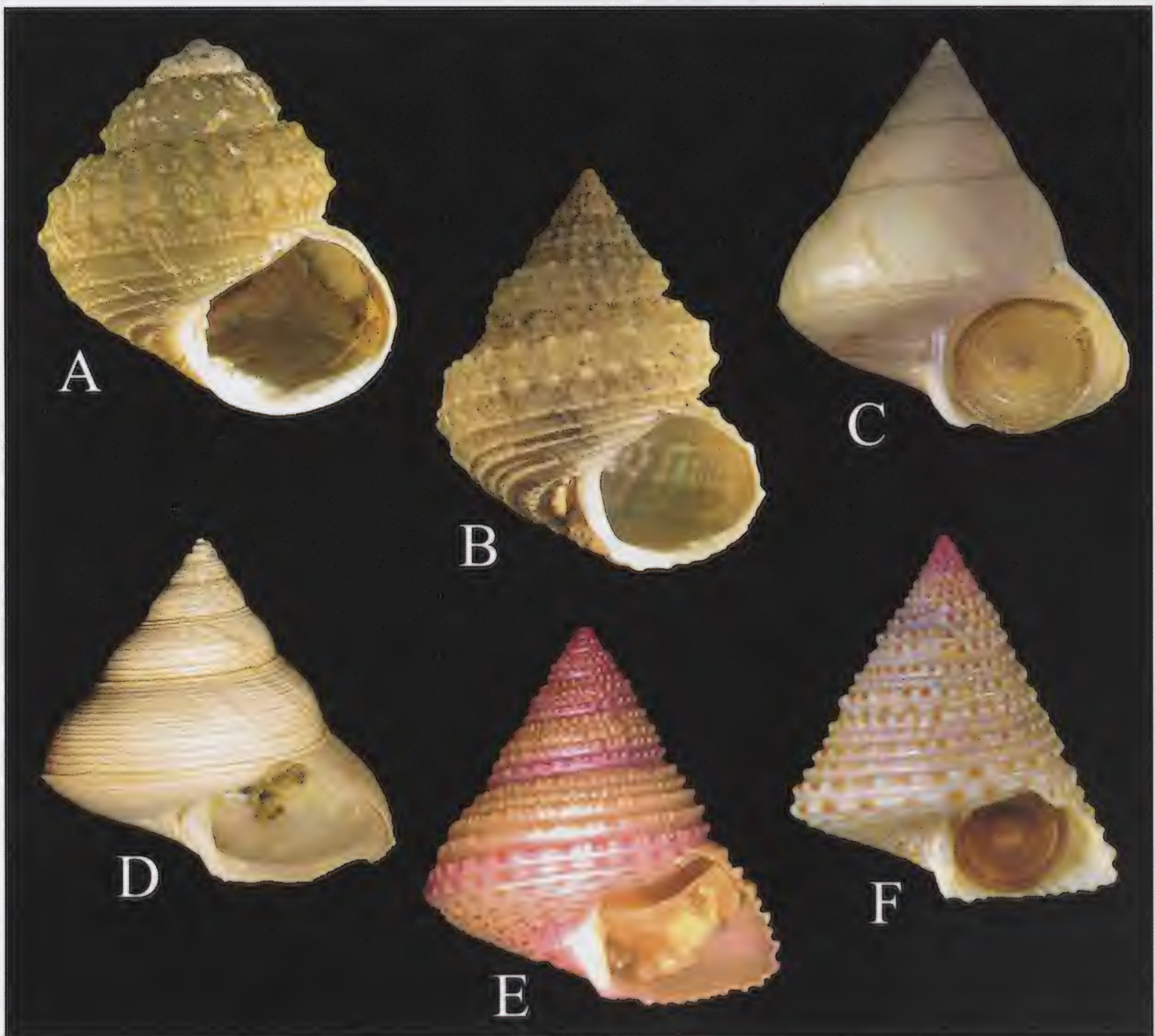


Figure 1. Alaskan Trochiform Gastropods. A = *Bathybembix baridii*. B = *Cidarina cidaris*. C = *Calliostoma platinum*. D = Cf. *Calliostoma platinum*. E = *Calliostoma annulatum*. F = *Calliostoma variegatum*.



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CLUB NEWS

2018 February General Meeting

Our February meeting was held on February 17, 2018 at Don and Jeanne Pisor's home in San Diego. There was food, beverages, and Bob Yin gave a fascinating "slide" presentation on underwater photography, including several video clips.

2018 March General Meeting

Our March meeting was held on March 17, 2018, at Paul and Deeanne Kanner's home in Los Angeles. There was food, beverages, and Paul Kanner gave a wonderful presentation on collecting California shells and showed off part of his extensive collection of self collected California shells.

2018 April Potluck and Auction

Our popular annual potluck and spring shell auction was held on April 14, 2018 at the usual venue, Dr. Wes Farmer's clubhouse in San Diego. See article on page 130 for further information.

In Memoriam: Jules Hertz (May 25, 1929 - February 16, 2018)

by Hans Bertsch *

with contributions from Kelvin Barwick, Robert Dees, Wendy Enright, Marilyn Goldammer, Lindsey Groves, José H. Leal, Martin Schuler, Paul Tuskes, and Paul Valentich-Scott

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On a Friday afternoon in August 1970, Dave and Margaret Mulliner and Jules and Carole Hertz took off in the Mulliners' rolling rancho for Santo Tomas, a quiet little fishing village about 50 miles south of Ensenada, Baja California. Dave and Carole scuba dove, finding *Crossata californica* (Hinds, 1843) and many *Neobernaya spacidea* (Swainson, 1823). Carole described their collecting adventure in the October 1970 issue of *The Festivus*: "While Jules remained on the rocky excuse for a beach, acting as a combination lifeguard and babysitter, he collected some of the best finds. The Mexican fishermen had just brought in a load of abalone and cleaned out the meat. They took the meat and all the 'good' abalone shells and left the entrails and the few 'too small' *Haliotis sorenseni* and *assimilis* behind. Jules gloated that he'd done as well as we—and without a wetsuit!"

Sadly, on 16 February 2018, Jules passed away in his sleep at home, after his strong fight against lung cancer. Jules was born in Passaic, New Jersey. After graduating from Passaic High School, he studied Chemical Engineering at Newark College of Engineering, earning a B.S. degree. He and Carole moved to San Diego when he was hired by General Dynamics, where he worked for over 30 years as Manager of Materials and Processing. He received many awards and patents in this field. His precise thinking skills translated easily into malacology. He and Carole were early members of the San Diego Shell Club, enthusiastically developing a "club newsletter" into a professional peer-reviewed journal. They collected shells from around the world, including the Pacific coast of North America, Mexico, Fiji, and Australia, publishing their findings and developing an important private collection of well-curated specimens.

Some memories from his friends and colleagues describe Jules's enthusiasm, knowledge, and contributions:

"I was sorry to hear about Jules passing away. I did not know Jules well, since Carole was the one I most often interacted with. While no shrinking violet, Jules was the quiet one. They made such a great team editing *The Festivus* all those years." (Kelvin Barwick)

"Very sorry to hear about Jules. He was always especially courteous, highly knowledgeable about shells, and always interested to hear what you were doing. When I first joined the SDSC, he and Carole made me feel especially welcome and treated me like I knew things, which was only slightly, if even barely true. When I last saw him, a few weeks before he passed away, he joked about a paper he had written many years ago on shells of Antarctica (which I was soon to visit), saying he probably didn't get everything exactly right, but at least there was enough good stuff for people to get started with. Knowing Jules, I'm sure everything he said was well researched and about as right

as anybody could ask. His leadership and devotion to the San Diego Club accounts for its multi-year history as one of the finest shell clubs in the world. Jules was a fine man and respected by everyone who knew him. He was a quiet man, extraordinarily selfless, who gave freely of what he knew and who was undeceived about what he didn't know for sure. Maybe like what we'd all like to be.” (Robert Dees)



Figure 1. Jules and Carole at the June 2013 meeting of the Western Society of Malacologists in San Diego; photo by Paul Valentich-Scott.

“I was so sad to hear about Jules’s passing and my thoughts are with Carole and the rest of his family. Jules was always warm and welcoming. He encouraged me and made me feel that he shared my interests and was just as curious about what I was studying as I was. I am glad that I knew Jules, even just a little bit.” (Wendy Enright)

“I first met Jules and Carole through the San Diego Shell Club in 1975, and we have been close friends ever since. Over the years Jules, as well as Carole, has always made us feel a part of their lives and shared many of their family events with us. He will be truly missed.” (Marilyn Goldammer)

“Jules was the text-book definition of a gentleman...always.” (Lindsey Groves)



Figure 2. Carole, Wes Farmer, and Jules at the January 2014 SCUM (Southern California Unified Malacologists) meeting in San Diego; photo by Hans Bertsch.

“I always enjoyed Jules and Carole’s company during the American Malacological Society and Conchologists of America meetings which we participated in together. Jules was a true ambassador to the malacological and conchological communities in Southern California: he was one of my main contacts in the San Diego area, and we visited several times during my visits to that part of the coast. He will be sorely missed.” (José H. Leal)

“I remember joining the San Diego Shell Club while I was in high school back in 1972. At the first meeting, Jules and Carole both made me feel very welcome as a new member and have always been true friends in the shell club. I remember that Jules had a long run of identifying micro-shells that adorned many pages of *The Festivus*, as he would sift through gallons of collected grunge from around the world, most especially Baja California. He would usually find small gems that would normally go unnoticed by the average shell collector. Jules served tirelessly and endlessly with Carole to make *The Festivus* one of the longest-running and most successful pieces of literature in the field of malacology and conchology.” (Martin Schuler)

“In my early days of studying shells, Jules was always willing to look over my identification of both small and micro-shells. I learned to watch his head-waving and therefore knew if I was right or wrong before he spoke. In times past he had contributed a number of papers on small shells in our region, the ones you don’t necessarily see in books.” (Paul Tuskes)

“A few thought about Jules: My top thoughts are his easy-going nature, a very, very dry humor, sly smile, husky laugh, razor-sharp engineer’s mind, and generosity of time. I met Jules sometime in the late 1970s at a WSM meeting. He was kind and friendly, a ‘background support’ to his bubbly wife Carole. Jules was very methodical to everything he did. He loved bivalves, but was always a bit cautious on his identifications. He always wanted to get it right. He was also methodical about collecting and curating shells. Their personal collection is very well curated and extensive. Jules extensively helped with the two Bivalve Seashell books (northern and tropical). He *copy-edited over 7,000 references in 8 point type, line by line looking for typographic, style, and

punctuation errors. This was an exceedingly generous thing to do, and he found hundreds of errors that we fixed before publication. He also read all of the descriptions in the first book and greatly assisted with the telegraphic style. All in all, Jules was a kind, generous, and thoughtful guy. He will be missed.” (Paul Valentich-Scott)



Figure 3. Jules and Carole, Paul Valentich-Scott and wife Lynn at the July 2015 meeting of the San Diego Shell Club; photo by Hans Bertsch.

Our good friend, club leader, and fellow shell-lover Jules Hertz leaves his wife Carole, sister Milly, daughters Ruth and Suzanne and grandchildren Enrico, Emilia, Chase, and Grant fond memories. And to us, friends and colleagues, part of his extended family, he leaves a bond of the remembrance of his life well lived. Moments on the seashore, while searching for shells, are treasures he taught and shared with us. “The sound of the rising tide—you cannot help hearing it if you have an attentive ear” (Thich Nhat Hahn, Buddhist poet). Attentive always, I’m sure Jules would wish us fair winds and following seas.



Figure 4. Carole and Jules at the San Diego Shell Club auction, April 2016; photo by Bob Abela.

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Compiled by Hans Bertsch and Robert Dees

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THE FESTIVUS

ISSUE 2

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New publication: *Seashells of Southern California - Marine Shells of the Californian Province*, by **David P. Berschauer and Roger N. Clark**. Covering the majority of the marine mollusks from Point Conception, California to Punta Eugenia, Baja California Sur, Mexico. This is the first field guide published on this biogeographical province in forty years, and a must have for every collector. Available exclusively through the San Diego Shell Club. Price \$30 plus 8% sales tax and shipping at actual costs.

The Club's Spring Potluck and Auction

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The 2018 April Shell Auction went off without a hitch. There were over 110 unique shells in the oral auction, about 75 or so items for the silent auction featuring a large variety of corals as well as hundreds of \$5 and \$1 shells to sort through and select. The potluck featured a variety of foods from homemade lasagna (thanks to Jeanne Pisor) to fresh spring rolls (thanks to Dung Vo). My favorite was the oriental style fried chicken wings. The deserts were exceptional with a strawberry/cheese cake pie made by Lisa Lindahl.



Figure 1. Jeanne Pisor, Carole Hertz, Don Pisor and Larry Buck from left to right.



Figure 2. Club sales table at the April Auction.

While a number of our usual attendees were not present for the festivities because of prior commitments (*e.g.*, trip to Australia) we had some members attend that we have not seen for a while; we have missed seeing Carole Hertz! All I can say to those who were not able to attend is: "Get your priorities straight!", only joking. All-in-all we had an excellent turnout and one of the more successful auctions with the second largest gross income in the past ten years. Some of the special shells that were up for sale at the auction included: *Cypraea friendii vercoi lentiginosa* *Cypraea leucodon*, *Cypraea porteri*, *Cypraea venusta roseoimmaculata*, *Pleurotomaria caledonicus*, *Pleurotomaria atlantica*, *Morum dennisoni*, and *Strombus galeatus*. We also had some fantastic art for sale from our own Lisa Lindahl. What a great event! Special thanks to Dr. Wes Farmer for allowing the SDSC to use his homeowner's association clubhouse for our auction, to the volunteers who set up the auction, to all of you who brought food for the potluck, to Lisa Lindahl for allowing the Club to feature some of her beautiful pieces art, and to all of you who helped in cleaning up after the auction.

We are continuing to seek out and obtain those special shells for your collections. Our hope is to have these at our next auction in November. Hope to see you then. Also please join us at the West Coast Shell Show on August 25th and 26th in Balboa Park and for the 2018 Conchologists of America Conference at the Sheraton Hotel across from the San Diego Airport on August 29th through September 2nd.

A Pictorial Review of the Types of Bivalve Hinge Teeth

David P. Berschauer

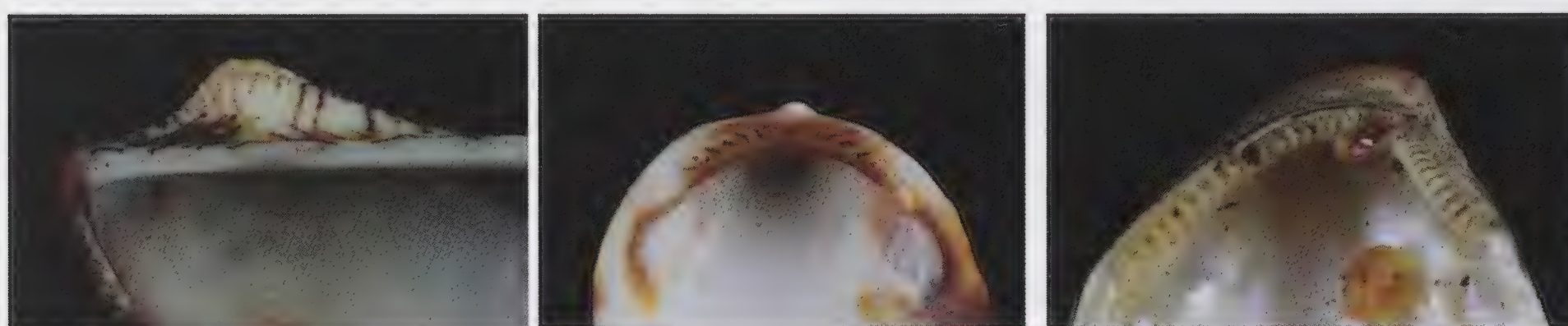
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shellcollection@hotmail.com

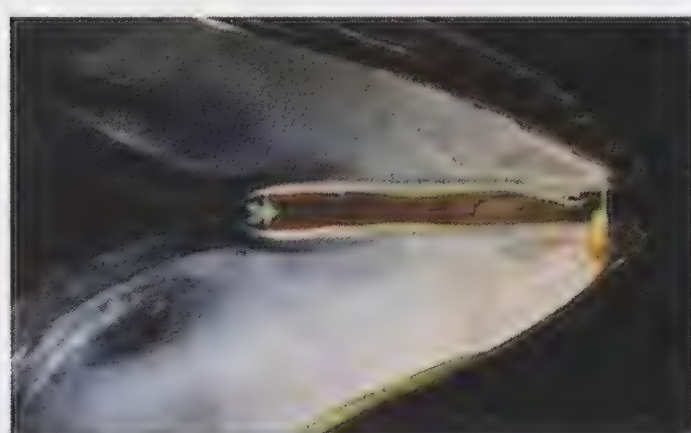
In most families of Bivalvia the two valves of their shell are almost perfectly symmetrical with one another and are joined together on a hinge line at the dorsal edge to the valves. The connection between the two valves is usually joined by a strong and flexible hinge ligament and articulated with a solid shell structure called hinge teeth. The presence or absence of hinge teeth, and the specific morphological structure thereof, is an important feature in identifying different families of bivalves and is therefore a frequently morphological feature used in classification. A formal terminology exists to describe the different types of hinge teeth dentition.

Some of the major types of hinge teeth are described and illustrated below.

Taxodont: The taxodont hinge shows either one or two rows of similar interlocking teeth on either side of the umbones. These hinge teeth are found in Arcidae, Glycymerididae, and Nuculidae.



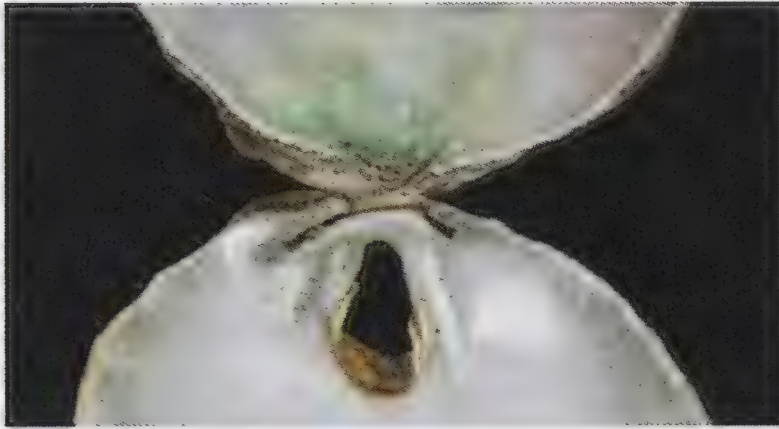
Dysodont: The dysodont hinge shows a strong ligament along the hinge line with weak teeth near the umbones. These hinge teeth are found in Mytilidae.



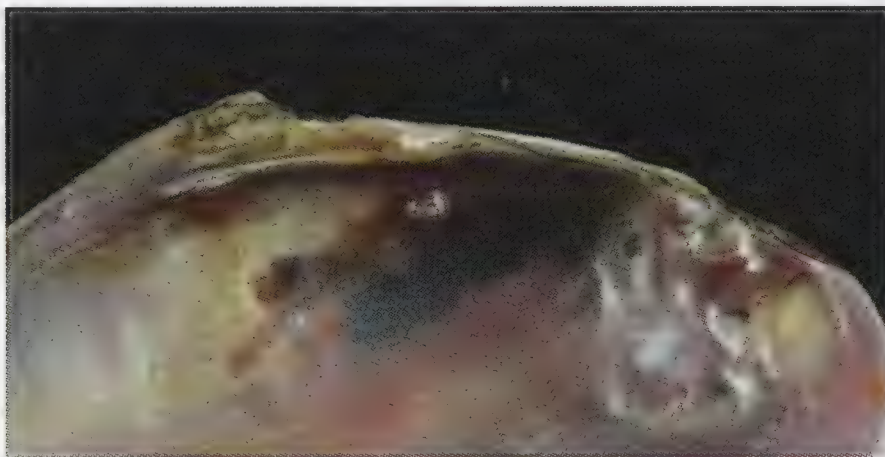
Isodont: The isodont hinge has lateral tubercles and sockets on either side of a strong thick ligament known as a resilium. These hinge teeth are found in Ostreidae, Pectinidae, Spondylidae, and Plicatulidae.



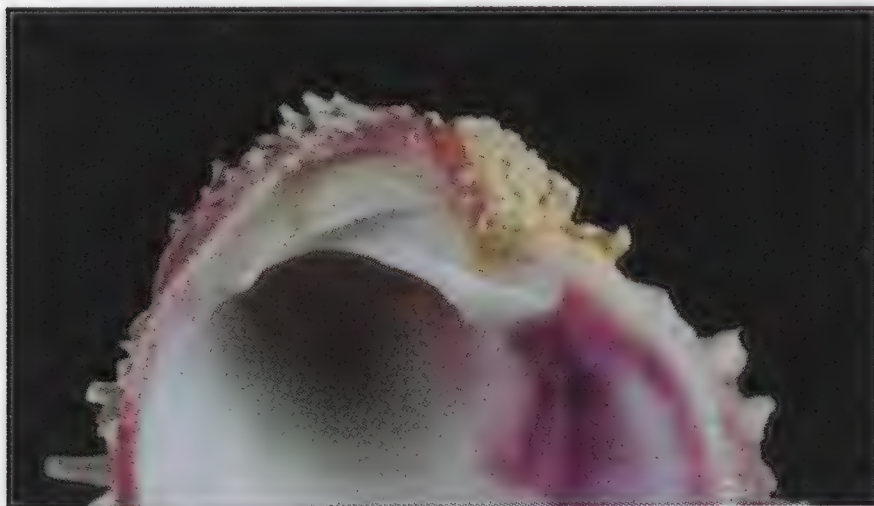
Crurae: The crurae hinge has lamellar ridges on or near the hinge plate which together with the hinge ligament function as hinge teeth. These hinge teeth are found in Anomidae and Dimyidae.



Schizodont: The schizodont hinge has reverse “V” shaped scissurate teeth often associated with an elongated lateral tooth. These hinge teeth are found in most Unionidae freshwater mussels.



Pachyodont: The pachyodont hinge has large tubercles with corresponding pits on the adjacent valve. These hinge teeth are found in Chamidae.



Heterodont: The heterodont hinge has two to three wedge shaped cardinal teeth adjacent to the umbones positioned between elongated lateral teeth on the anterior and posterior margins. This is one of the most common hinge types. These hinge teeth are found in the Veneridae, Cardiidae and many other major families.



Desmodont: The desmodont hinge has a large ligamentous resiliifer which replaces the cardinal teeth. These hinge teeth are found in Myidae.



Anodont: The anodont hinge type consists of a single strong ligament or a series of transverse ligamental grooves, and lacks any defining dentition which could otherwise be characterized as hinge teeth. This hinge type is found in Pinnidae, Isognomonidae, Pteriidae and Anodonta.



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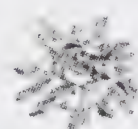


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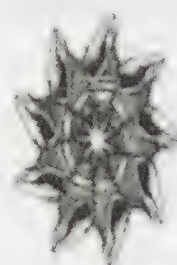
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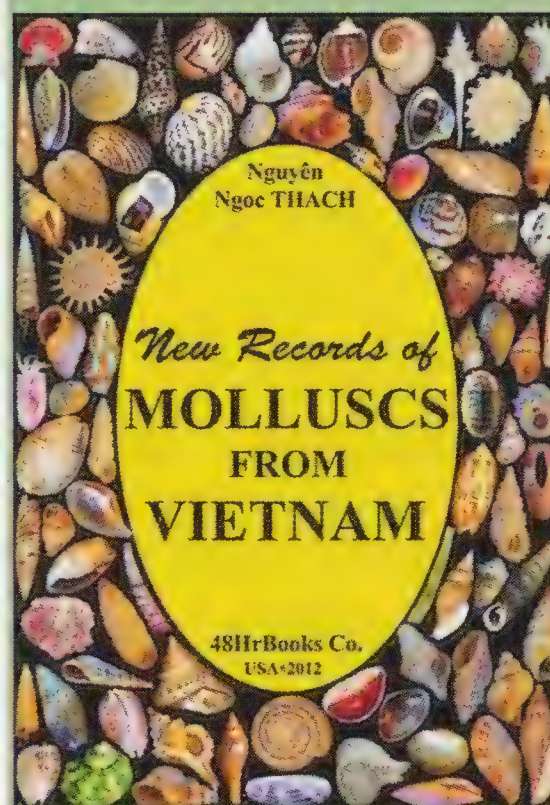
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Back cover: *Pteropurpura festiva*, *Euvola diegensis*, *Dalloccardia quadragenaria*, *Mopalia muscosa*, *Cancellaria cooperi*, *Calliostoma annulatum*, and *Haliotis rufescens* from back cover of upcoming book: *Sea Shells of Southern California - Marine Shells of the Californian Province*. (Cover artistic credit: Rex Stilwill).

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THE Festivus

Vol. 50(3)

August 2018



A new Forreriella from the Sea of Cortez
An Inter-Generic Hybrid Strombid
Reflections on Bahia de Los Angeles, Mexico
Amphidromus, cones, cowries, and more

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A publication of the San Diego Shell Club

Volume: 50

August 2018

ISSUE 3

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Specimen of *Forreria corteziana* n. sp. overlaid on a sunset scene with a shrimp trawler in the Sea of Cortez, Mexico.
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A New Species of *Forreria* (Gastropoda: Muricidae: Ocenebrinae) from the Sea of Cortez, Mexico

David P. Berschauer ¹, Edward J. Petuch ² and Roger N. Clark ³

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ABSTRACT A new muricid is described from deep water in the Wagner Basin, in the northern Sea of Cortez, Mexico, 65 kilometers south of Puerto Peñasco, Sonora, Mexico. The only living relative of this new species is *Forreria belcheri* (Hinds, 1843), which ranges from Santa Barbara, California, to Laguna Scammons, Baja California, Mexico. This new endemic species has been brought to light by shrimp trawling activities, and is thought to be a relict deep water population left behind in the northern Sea of Cortez during the Pleistocene.

KEY WORDS *Forreria*, *F. belcheri*, *F. corteziana* n. sp., Sea of Cortez, relictual species

INTRODUCTION

In the 20th century, many workers conducted extensive field work in the Sea of Cortez and made discoveries of previously unknown species in these tropical Panamic Province waters. Many of the new species were brought to the attention of science by shrimp trawlers who fished the area west of Guaymas, Sonora, Mexico. Despite over 150 years of extensive research in the Sea of Cortez, including a lifetime of work by Dr. Hans Bertsch off Bahía de Los Ángeles, Baja California, Mexico, the deep water basins of the northern part of the Sea of Cortez remain largely unexplored (Bertsch & Rosas, 2016). Recently an interesting large muricid was found by shrimp trawling activities in the Wagner Basin off Puerto Peñasco, Sonora, Mexico, some 550 kilometers northwest of Guaymas. (see Figure 1 for map of the northern Sea of Cortez) This large and interesting muricid is recognized here as a new species of

Forreria, related to *F. belcheri* (Hinds, 1843), which inhabits the temperate waters of the Californian Province (Berschauer & Clark, 2018). Evidence suggests that this new deep water muricid represents a relictual population that evolved from *F. belcheri* during periods of reproductive isolation due to lowered sea levels during the Pleistocene.

Abbreviations. Type specimens of the *Forreria corteziana* Berschauer, Petuch and Clark, new species, are deposited in the following institutions:

LACM = Natural History Museum of Los Angeles County; Los Angeles, CA

SBMNH = Santa Barbara Museum of Natural History; Santa Barbara, CA

CASIZ = California Academy of Sciences; San Francisco, CA

ANSP = Academy of Natural Sciences of Drexel University; Philadelphia, PA

BMSM - Bailey-Matthews National Shell
Museum; Sanibel, FL

USNM = Smithsonian National Museum of
Natural History; Washington DC

MNHN = Muséum National d'Histoire Naturelle;
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Figure 1. Map of the northern Sea of Cortez, Mexico, showing the approximate location of the Wagner Basin with a red circle.

SYSTEMATICS

Class Gastropoda

Subclass Sorbeoconcha

Order Prosobranchia

Infraorder Neogastropoda

Superfamily Muricoidea

Family Muricidae

Subfamily Ocenebrinae

Genus *Forreria* Jousseaume, 1880

Forreria corteziana Berschauer, Petuch and
Clark, new species

(Figure 2 A-C; Figure 3 A-F)

Description. Medium to large sized shell, white protoconch proportionately large composed of three bulbous whorls, seven to eight teloconch whorls, spinose on shoulder, relatively high spire, narrow shoulder which tapers to sharp bend below aperture, long open siphonal canal which is more than one-third body length, siphonal canal slightly recurved, small open umbilicus, sharp suture between whorls; shoulder bears seven to eight relatively long, open, delicate spines formed from blade like varix protruding from upper third of body whorl approaching shoulder; spines guttered and rounded at back, pointing mostly upwards; light tan to white body color often with muted peach to pink longitudinal markings; apex white; aperture smooth and bright white; body whorl almost smooth, bearing weak microsculpture consisting of flattened smooth radial cords crossed by weak growth lines; outer lip smooth, weak spiral groove on body whorl which terminates in small labral tooth which appears to be vestigial. Operculum large, brown, D-shaped, filling aperture, with concentric growth lines, nucleus lateral; interior surface with C-shaped callous, broad and thick on outside edge, thinning dramatically on anterior and posterior edges; interior area with irregular vermiform costae.

Type Material. In addition to the type material a total of twenty seven specimens were examined.

HOLOTYPE: LACM 3601, length 91.7 mm.

PARATYPES:

No. 1 - LACM 3602, length 101.2 mm.

No. 2 - SBMNH 166000, length 79.3 mm

No. 3 - CASIZ 224327, length 83.2 mm

No. 4 - ANSP 476376, length 89.8 mm

No. 5 - BMSM 125552, length 88.5 mm

No. 6 - USNM 1490908, length 75.5 mm

No. 7 - MNHN IM-2014-6953, length 76.8 mm

OTHER MATERIAL EXAMINED: Twelve specimens, 82.4 to 104.0 mm in the research collection of David P. Berschauer; two specimens, 81.0 mm, and 92.0 mm in the research collection of Edward J. Petuch; four specimens, 76.5 to 98.6 mm in the research collection of Roger N. Clark; one specimen, 89.3 mm, in the collection of David B. Waller.

Type Locality. Trawled from 140 m depth, in a restricted 20 km area, at the bottom of the Wagner Basin, in the northern Sea of Cortez, Mexico, 65 km south of Puerto Peñasco, Sonora, Mexico.

Distribution. Known only from the type locality, the Wagner Basin, Sea of Cortez, Mexico.

Size Range. Adults 75 to 104 mm in length. Typically from 80 to 90 mm in length.

Ecology. The new species was trawled by shrimpers in a deep water basin at 140 m on a black muddy-silt bottom. Based upon the small, almost vestigial labral tooth, the authors presume that it feeds exclusively on thin shelled bivalves which inhabit the basin. The new species may also be a scavenger in similar fashion to other known deep water muricids.

Etymology. Named for the Sea of Cortez, the geographic region where this species is found.

Discussion. *Forreria corteziana* n. sp. is closest to *F. belcheri*, a Californian Province species, from which it is easily separable. *F. belcheri* has overall a heavier shell, a broader shoulder, ten to twelve knob-like spines on the shoulder, and a shorter siphonal canal. (see Figure 2 D-E). In contrast, *F. corteziana* has a thinner lighter shell,

with a narrower shoulder, seven to eight relatively long delicate spines, a substantially longer and thinner siphonal canal, and a smaller labral tooth. Finally, the type of genus, *F. belcheri*, has a deep spiral groove in the body whorl which terminates in a large well formed labral tooth on the outer lip (Kool, 1993; Vermeij, 2001), whereas *F. corteziana* has a weak spiral groove which terminates in a small labral tooth (Figure 4). None of the ten or so fossil species of *Forreria* from California or northern Baja California, Mexico, have the long delicate shape of *F. corteziana* n. sp. or are remotely similar in appearance (Vermeij, 2001; Powell, 2005; Charles L. Powell, II, personal communication) Figure 3 illustrates three specimens to show some of the variability in this new *Forreria* species.

An interesting ecological note is that almost every individual of *Forreria corteziana* n. sp. (and other muricid gastropods such as *Pteropurpura centrifuga* (Hinds, 1844)) brought up by the shrimp trawler from the Wagner Basin had one or two live anemones on the back of its shell, often wrapped around the long spines (Figure 5). The species of anemone appears to be *Anthothoe carcinophila* (Verrill, 1869), and may have either an ectocommensal or mutualistic relationship with the gastropod; see Brusca, 1980.

Geological and Oceanographic History.

The new *Forreria* species is confined to the Wagner Basin, a small but deep depression at the northern end of the Sea of Cortez (also known as the Golfo de California) off Sonora, Mexico. The geometry, configuration, and bathymetry of this deep basin is an artifact of the intense geological activity that is associated with the rifting and opening of the Sea of Cortez. This northernmost basin formed as a downdropped block between two parallel

normal faults (the Wagner Fault to the east and the Consag Fault to the west) and a perpendicular transform fault system (the Ballenas Transform Fault to the south) in a pull-apart basinal structure. The Wagner Basin is also the southernmost end of the Cerro Prieto strike-slip system and is tectonically highly active (Gonzalez-Escobar *et al.*, 2009). Although the Sea of Cortez rift zone began forming around 6 million years ago (Messinian Age, Miocene), the Wagner Basin is one of the most recent geological structures to form, with its subsidence taking place only around 2 million years ago (Gelasian Age, Pleistocene) (Persaud *et al.*, 2003). Since that time, the sea floor within the small basin has dropped to over 250 m depth, generating a deep oval-shaped pocket within an area of shallower continental shelves, averaging only 25-75 m depths.

During the Early Pleistocene, the newly-formed Colorado River acted as a source of muddy, organic-rich sediments that filled much of the basin. The Colorado River was, and still is, also a source of fresh water effluent, forming a massive delta system between modern San Felipe and Puerto Peñasco. This delta system helped to preserve the marine environments of the Wagner Basin during the climatologically-catastrophic time of the Gelasian-Calabrian Age boundary, around 1.2 million years ago. During this glacially-induced cold time, sea levels dropped as much as 100 m, well below the depth of the shallow San Pedro Martir Sill, which extends from Isla Tiburon to Isla San Esteban in the northern one-third of the Sea of Cortez. This emergent sill effectively created two separate seas, with only the southern section having a direct connection to the Pacific Ocean. The northern section, which contained the Wagner Basin, became an isolated salt water lake and its resident organisms were cut off, reproductively, from their congeners to the south. Due to the surrounding extreme desert

conditions and high levels of evaporation, this isolated salt lake should have degenerated into a series of salt flats and brine pools, completely destroying the marine ecosystems that resided there. These extreme oceanographic conditions, however, failed to materialize during this time, primarily due to the continual input of fresh water from the Colorado River Delta. This kept the salinity at normal levels and allowed many of the original resident organisms to persist on within this geographically-small isolated inland sea.

As sea levels were dropping at the end of the Gelasian Age, the Eastern Pacific water temperatures also were lowered drastically as the main oceanic basin began to cool and accumulate sea ice at higher latitudes. These cooler water conditions would have allowed numerous cold-tolerant Californian genera to migrate down the outer coast of the Baja California Peninsula and enter the Sea of Cortez. Just prior to the emergence of the San Pedro Martir Sill in late Gelasian time, these Californian migrant genera apparently became established within the Wagner Basin, living on the organic-rich sea floors that were now established in the central deeper water area.

The resultant reproductive isolation, due to the formation of the inland sea, resulted in the evolution of several endemic species that were offshoots of widespread Californian Province gastropod genera. Some of these include the ocenebrine muricid *Forreria* and its endemic offshoot *F. corteziana* n. sp. and the fascioliid genus *Hesperaptyxis* and its locally-restricted offshoots *H. felipensis* (Lowe, 1935) and *H. fredbakeri* (Lowe, 1935). These two California-based genera, and their endemic northern Sea of Cortez species, occur together with other highly-restricted endemic taxa, such as the tropically-derived ranellid *Turritriton gibbosus adairense* (Dall, 1910), the cypraeid

Macrocypraea cervinetta californica Lorenz, 2017 (recently described and illustrated as a new subspecies in Lorenz, 2017 on p. 290), the olivid *Americoliva corteziana* (Petuch and Sargent, 1986), the muricid *Eupleura limata* Dall, 1890, and the calliostomatid *Calliostoma palmeri* Dall, 1871. Another relict taxon which was similarly left behind to the northern Sea of Cortez during the Pleistocene is the bursid *Crossata sonorana* (Berry, 1960), which is virtually indistinguishable from a morphological form of its sister taxon *C. californica* (Hinds, 1844), although genetic testing of these two sister taxa remains to be conducted. (Powell & Berschauer, 2017). These endemic species apparently evolved within the isolated Pleistocene inland sea and have persisted on into the Recent as relict taxa in the northernmost Sea of Cortez. The cold-water genus *Forreria* has apparently found a refugium in the deep, cooler waters of the Wagner Basin, where it survives as a fragile, limited population within a very limited geographic area and narrow bathymetric range.

ACKNOWLEDGMENTS

For the collection of type material of the new species, the donation of multiple study specimens, and for sharing information about the marine environments in which this fascinating new muricid was found we thank Daniel A. Notek, without whom this paper would never have come to fruition. We also thank Charles L. Powell, II, Chong Chen, and Roland Houart for sharing their invaluable expertise and for reviewing the manuscript.

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Figure 2. A, B, C = *Forreria corteziana* Berschauer, Petuch & Clark, new species, holotype LACM 3601, 91.7 mm in length, Wagner Basin, trawled at 140 m depth in the northern Sea of Cortez, Mexico; C, D = *F. belcheri* (Hinds, 1843), specimen from the collection of the senior author measuring 109.6 mm in length, from Newport Bay, California.



Figure 3. A, B = *F. corteziana* Berschauer, Petuch & Clark, new species, specimen from the collection of the senior author measuring 82.4 mm in length from the same locality as the holotype; C, D = *F. corteziana* Berschauer, Petuch & Clark, new species, specimen from the collection of the senior author measuring 82.9 mm in length from the same locality as the holotype; E, F = *F. corteziana* Berschauer, Petuch & Clark, new species, specimen from the David B. Waller collection measuring 89.3 mm in length from the same locality as the holotype.

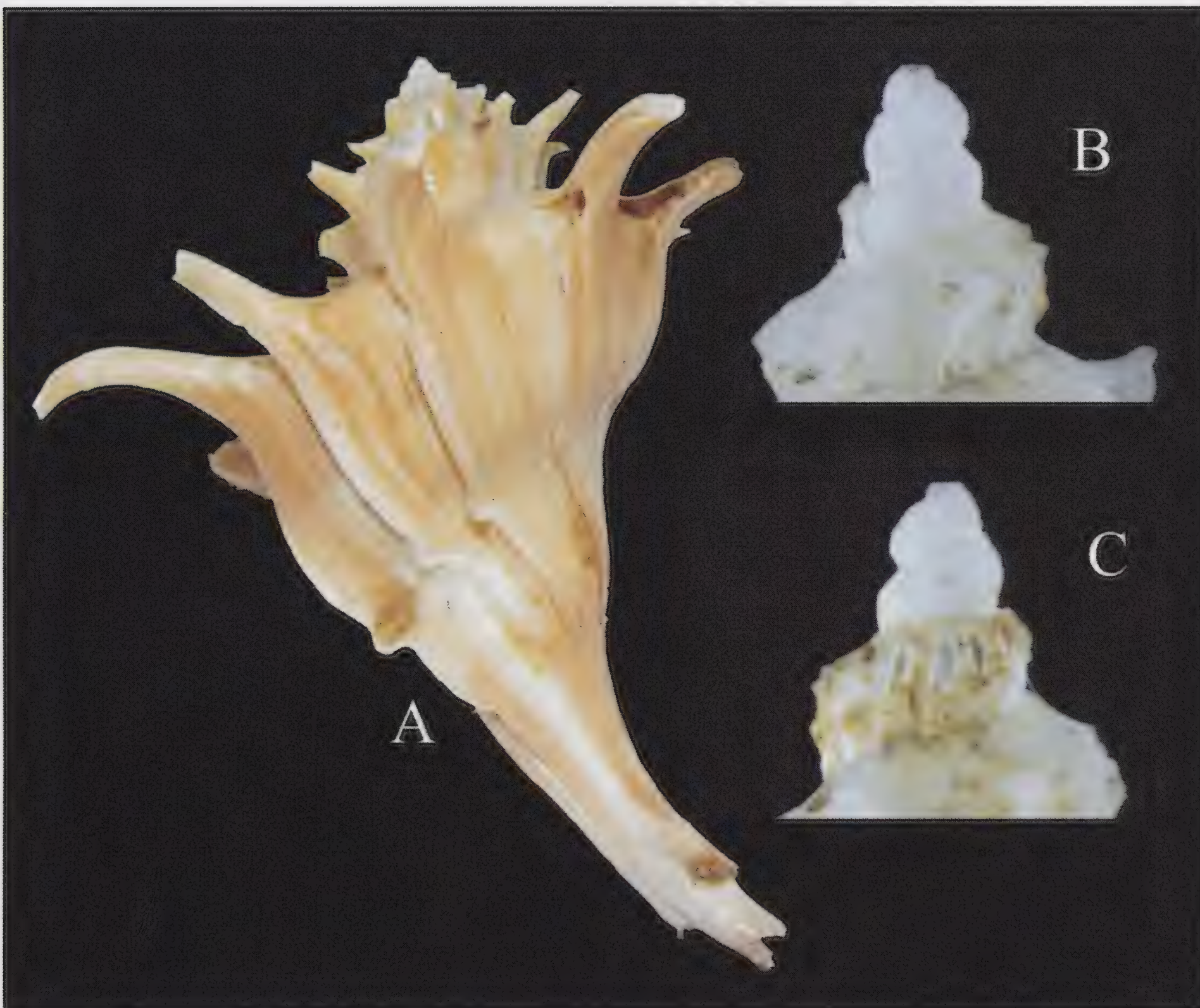


Figure 4. *F. corteziana* Berschauer, Petuch & Clark, new species: A = weak spiral groove on body whorl which terminates in a small labral tooth; B, C = front and back macro images of protoconch.



Figure 5. *F. corteziana* Berschauer, Petuch & Clark, new species, specimen with an anemone which appears to be *Anthothoe carcinophila* (Verrill, 1869) trawled at 140 m depth in the Wagner Basin, northern Sea of Cortez, Mexico.

A new subspecies of *Amphidromus* (*Amphidromus*) *capistratus* von Martens, 1903 from Sabah, Malaysia

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ABSTRACT This paper describes a new subspecies of *Amphidromus* (*Amphidromus*) *capistratus* von Martens, 1903 from Sabah, Malaysia. A comparison with three close relatives, found conchological features that distinguish it from those species: *A. (A.) mundus* (Pfeiffer, 1853), *A. (A.) entobaptus* Dohrn, 1889 and *A. (A.) similis* Pilsbry, 1900.

KEY WORDS *Amphidromus*, *capistratus*, *chuai*, Tawau District, Semporna District, Sabah, Malaysia.

INTRODUCTION

Late 2012, Andy Tan from Malaysia showed me photos of empty shells of an unidentified *Amphidromus* Albers, 1850, originally collected by the late Mr. Chua whilst working in the logging industry in Tawau District, Sabah, Malaysia (Figure 1.). Only six adult shells were available and sent to me for study. The nearest species I could find as a probable name for these shells was *Amphidromus* (*Amphidromus*) *capistratus* von Martens, 1903, only known from three syntypes with the type locality of “Kutei Sultanat, Ost-Borneo”. That area in modern Indonesia is now four separate political divisions, making it hard to identify a specific location or habitat in which that species lives. Regardless at least 300 km separate both populations, and conchological features alone separate them from each other and their congeners studied here: *A. (A.) mundus* (Pfeiffer, 1853) from Pulau Besar, Johor, Malaysia; *A. (A.) entobaptus* Dohrn, 1889 from Palawan Province, Philippines; and *A. (A.) similis* Pilsbry, 1900 from southern Sarawak, Malaysia and NW Kalimantan, Indonesia.

In February 2017, I received a seventh shell that was possibly live-collected by Mr. Chua purchased from Andy Tan. This shell has a full pattern, unfaded colours and its sculpture is well preserved. A search of museum databases found photos of further specimens like Mr. Chua's snail, collected on islands of the Semporna District, Sabah between 1904 and 2007 (Figure 1.). This area is close to where Mr. Chua collected his specimens. The Semporna shells match the conchological features of the Tawau shells and thus considered as the same species, although most of them are “plain” and only a few have stripes. A comparison made with *A. (A.) capistratus* found the snail from Sabah differs in pattern, coloration and last whorl sculpture, and described herein as *Amphidromus* (*Amphidromus*) *capistratus chuai* new subspecies.



Figure 1 Location map showing the type locality for *Amphidromus (Amphidromus) capistratus chuai* new subspecies (blue oval) and secondary range based on paratypes (red oval). Modified from a map of “Sandakan” (University of Texas Libraries, 2017).

Materials and Methods. Shells were measured using digital Vernier callipers (0.01 mm resolution). The abbreviation “D” aligns with the usage of ‘diameter’ in the literature. Shell sculpture was examined under low magnification (10x) using a jeweller's loupe. Whorl count includes the apex as per Haniel (1921, p. 22, fig. 10) and counted precise to 0.125 ($\frac{1}{8}$ whorl). Shell weight was measured in grams (g) using a pocket-sized electronic scale (capacity 300 g x 0.01 g). The term ‘paries’ (adj. parietal) refers to the ‘inner apertural wall’, and ‘palatum’ (adj. palatal) is the interior surface of the ‘outer apertural wall’. Relative shell sizes for the subgenus *Amphidromus* mentioned are as follows: small < 40 mm, medium 40-60 mm and large > 60 mm.

Abbreviations used for museums and private collections:

BMC:	Borneensis Malacology Collection, Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia
BOR.MOL:	BMC specimen label code
CUMZ:	Chulalongkorn University, Museum of Zoology, Bangkok, Thailand
MCZ:	The Louis Agassiz Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
MN:	Museum für Naturkunde, Leibniz Institute for Research on Evolution and Biodiversity, Berlin, Germany
NBC:	Naturalis Biodiversity Center, Leiden, Netherlands
NHMUK:	Natural History Museum, London, England, UK
ZMB:	MN specimen label code with abbreviation for the museum's previous name, Zoologisches Museum Berlin
ZMA.MOLL:	NBC specimen label code, ex-Zoölogisch Museum Amsterdam
CF:	Chua Family collection
JP:	Jeff Parsons collection

Abbreviations for shell morphometry and shell coiling:

D:	shell width (abbreviation for ‘diameter’ as per literature usage)
H:	shell height
H/D:	shell height/shell width ratio
N:	whorl count
W:	shell weight
DEX:	dextral coiling
SIN:	sinistral coiling

Of the empty shells obtained by the late Mr. Chua, the shell selected as the holotype is now in the NHMUK and three paratypes remain in the Chua Family collection (Sabah, Malaysia). Paratypes housed in the BMC (Brahim, 2015), NBC (BioPortal, 2016) and MCZ (photos provided by Adam J. Baldinger, Curatorial Associate/Collection Manager) were studied using digital images found on their respective websites or provided personally. Christine Zorn (Malacological Collection Curator, MN) supplied the photos of the *A. (A.) capistratus capistratus* syntypes. Three additional specimens of the newly named subspecies (ex-CF) and remaining comparative material belong to the author's private collection (JP). Photography credits are as indicated below each image.

SYSTEMATICS

Family Camaenidae Pilsbry, 1895

Genus *Amphidromus* Albers, 1850

Subgenus *Amphidromus* Albers, 1850

Type species: *Helix perversa* Linnaeus, 1758

Amphidromus (Amphidromus) capistratus chuai
new subspecies

Figures 2–5

Type Material. Tawau District, Sabah, Malaysia [leg. Mr. Kim Chua] - **Holotype** (1 DEX, Figure 2) NHMUK 20170207; H 35.66 mm, D 20.44 mm, H/D 1.74, N 6.625 and W 1.96 g. **Paratypes** 1-3 (2 DEX, 1 SIN; CF, Figure 3): H 30.79-36.31 (av. 34.17) mm, D 20.13-21.24 (av. 20.77) mm, H/D 1.53-1.71 (av. 1.64), N 5.875-6.25 (av. 6.083) and W 1.52-1.77 (av. 1.67) g.

Semporna District, Sabah, Malaysia — **Paratypes** 4-49 (shells not measured): Maigu Id., ZMA.MOLL.396026 (2 DEX, leg. Mrs M. Saul Aug. 1904; Figure 4A); Selangan Id.

Forest Reserve, MCZ 230008 (1 DEX, leg. HG Keith, Aug 13 1948; Figure 4B); Bod Gaya Id., BOR.MOL 4724 (1 DEX, 1 SIN; Figure 4C), BOR.MOL 4777 (2 SIN; Figure 4D), BOR.MOL 4805 (1 DEX, 3 SIN; Figure 4E) and BOR.MOL 5324 (1 SIN; & 1 DEX, 1 SIN fragments; Figure 4F) [Leg. TS Liew, Abdul & Ladjia 02-06/05/2007]; and Bohey Dulang Id., BOR.MOL 4623 (4 SIN; & 3 SIN fragments; Figure 4G) [Leg. TS Liew 28-30/04/2007], BOR.MOL 4694 (1 DEX, 2 SIN adults; 2 SIN juveniles; & 7 DEX, 6 SIN fragments; Figure 4H) [Leg. TS Liew & Markus Ruf. 27/05/2007] and BOR.MOL 3520 (2 DEX, 17 SIN adults; & 1 DEX, 1 SIN juveniles) [Leg. M Schilthuizen & AS Cabanban 30/04/2005].

Other Material. Tawau District - (1 DEX, 2 SIN, leg. Mr. Kim Chua; JP, Figure 5) H 33.00-36.08 (av. 34.28) mm, D 19.61-20.43 (av. 20.04) mm, H/D 1.62–1.80 (av. 1.71), N 5.875-6.375 (av. 6.167) & W 1.48-2.10 (av. 1.72) g.

Semporna District (shells not measured) - Bod Gaya Id., BOR.MOL 4764 (1 DEX, 1 SIN adults; & 1 SIN juvenile) and BOR.MOL 4834 (1 SIN adult fragment) [Leg. TS Liew, Abdul & Ladjia 02-06/05/2007].

Type Locality. Commercially logged forest west of Taman Bukit Tawau (Tawau Hills Park), Tawau District, Sabah, Malaysia (Figure 1), with no specific site recorded by Mr. Chua. Based on logging activity at the time of his employment, and the fact the original forest has since been converted to roads and plantations of soft wood, oil palm or cacao, the type locality is here restricted to the residual forests along Sungai (River) Dumpas, Tawau District, Sabah.

Distribution. Based on museum material, this species also lives on the islands of Bod Gaya (Bodgaya or Gaya), Bohey Dulang (Boheydulang), Maigu (Maiga) and Selangan in

the Semporna District, Sabah, Malaysia (Figure 1).

Habitat. Lowland to hill mixed dipterocarp forest.

Animal and Soft Parts. Unknown; one specimen appears to have been live collected

(JP, Figure 5C), but the animal was removed and discarded many years ago, and all other specimens were collected as empty shells.

Etymology. Named in honour of the late Mr. Kim Chua, who collected this snail whilst working as a commercial logger.



Figure 2. *Amphidromus (Amphidromus) capistratus chuai* new subspecies, Holotype NHMUK 20170207 [photos: JP].

Comparative Material.

A. (A.) capistratus capistratus
Nominotypical subspecies
Figure 6

Type Material. H 39-47 mm, D 23-25.5 mm; & aperture height including lip 19-24.5 mm & excluding lip 15.5-20.5 mm [data: von Martens, 1903; Syntypes ZMB 59670, 1 DEX, 2 SIN, leg. M. Schmidt 1902; Figure 6].

Type Locality. Sultanat Kutei, Ost-Borneo with no further details provided.

Distribution. Sultanat Kutei, Ost-Borneo.

Habitat. Unknown.

Animal and soft parts. Unknown.

Original Description. (translated from von Martens, 1903).

Shell fusiform-ovate, flavous, white sutural zone rather narrow, decorated with an olivaceous-green basal fascia on the last whorl and a stripe of the same colour behind the aperture, both angularly conjunct; aperture height almost equal to the length of the shell.

Description. (based upon the holotype)

Shell small, dextral and solid, conic-ovate with a moderately long spire; apex subpapillate and slightly protruding. Surface eroded in places, protoconch and early teleoconch whorls worn smooth. Unworn parts of shell show coarse spiral striae overlaid by weak ridgelets on the spire; last whorl weakly spirally striate, worn early on the upper surface becoming subplicatulate behind the lip, and the base plicate. Whorls $6\frac{5}{8}$, convex apically and remainder subconvex; last whorl not inflated, non-descending and base gently convex, periphery rounded. Suture impressed on the upper whorls, becoming shallow and subcrenulate on the last whorl.

Protoconch whitish; next two whorls bright white with a grey suprasutural fillet; sutural margin grey becoming intense yellow on the penult. Lower whorls very pale lemon with brown oblique stripes, eluted at the end of the penult and early on the last whorl, distinct on the paries and behind the lip; either almost straight or ragged, and the final one (telostripe) separated from the lip by a gap of about twice its width. Stripes stop at a very faint white subsutural band on the last whorl, imperceptible on the penult; and bordered below by a whitish circumumbilical zone. Periostracum absent, shell denuded.

Aperture oblique, subovate and its base weakly effuse. Palatum dull white, translucent and showing the external markings. Scarcely perceptible, thin colourless parietal callus with two white tubercles: parieto-columellar, c. 6 mm sickle-shaped extension of the columellar margin; and parieto-labral, c. 4 mm long subpyramidal adjunct of a slightly ascending lip terminus. Outer lip gleamy white, strongly reflected, very narrowly expanded and very thick; lip edge bent backward a little and

thickened. Columella gleamy white, subcompressed and narrowly twisted, its base subreflexed dorsally. Columellar margin adnate, dilated as a thick callus covering the umbilicus.

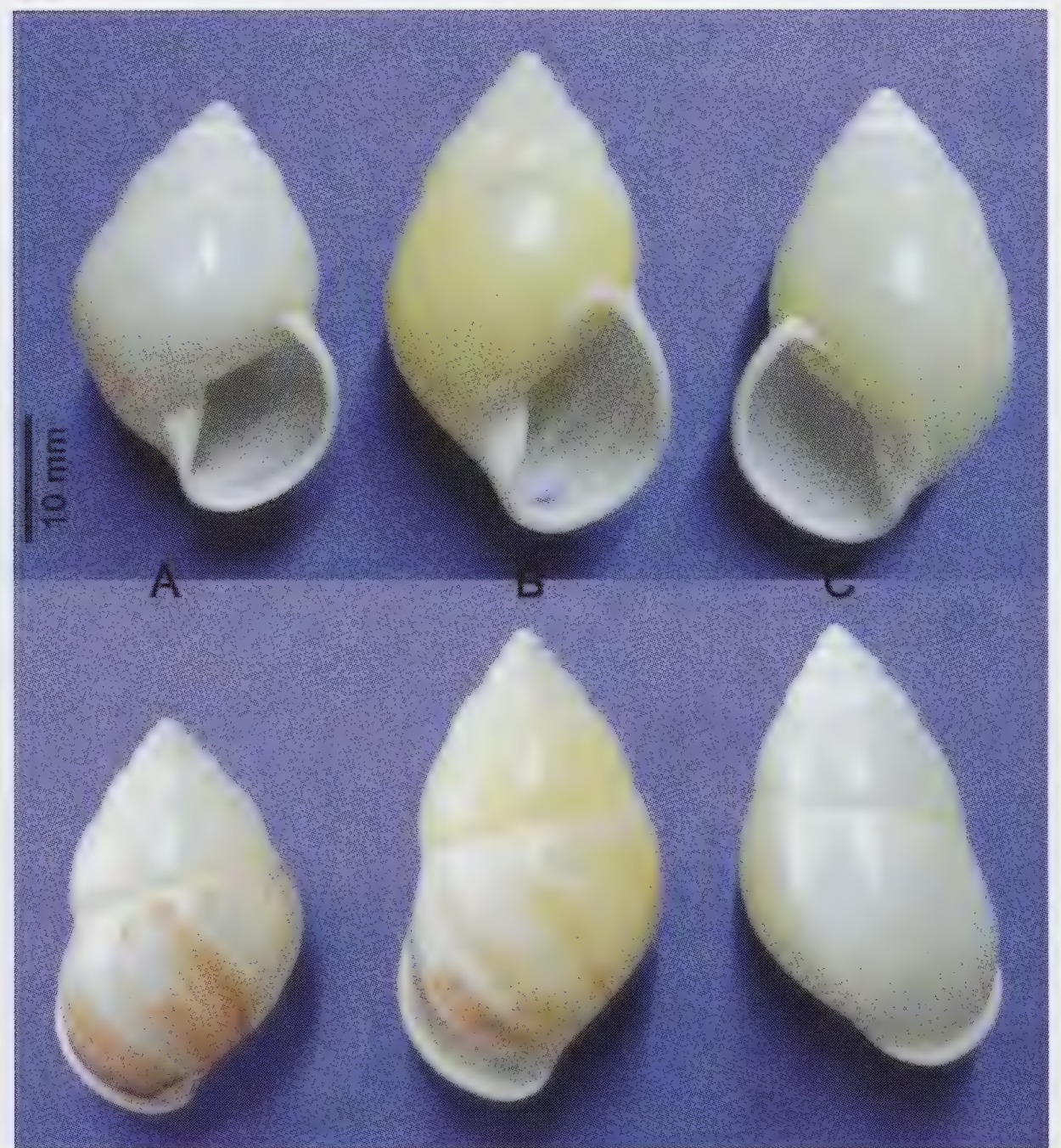


Figure 3. A. (A.) *c. chuai* n. ssp. from Tawau District, Sabah (CF): A. paratype 1, B. paratype 2 and C. paratype 3 [photos: JP]

Shell Variation.

All shells measured are small for the genus, either dextral or sinistral. Shape is variable: conic-ovate (Figures 3B-C), ventricose-ovate (Figure 3A), ovate (Figure 5A) or oblong-ovate (Figure 4C). Spire height and aperture height are equal (Figure 4E) to spire slightly longer (Figure 4D). The penult is rounded or obsoletely subangulated (Figure 3A). Subsutural region on the last whorl is compressed (Figures 3A, 4F) or not. Many shells studied have an abraded surface and patchy erosion, due to natural degradation prior to collection. Shells with well-preserved sculpture show a smooth protoconch,

and the spire has coarse spiral striae, becoming fine on the penult, overlaid by growth lines, threadlets and threads (tips puckered at the suture), and occasionally weak pliculae. Last whorl's upper surface as per the penult and the base plicate, the plicae weakly cross the periphery mid-whorl and become coarser behind the lip (Figures 5B-C). Last whorl sculpture may be coarser (plicate, Figure 4B), or finer (pliculate, Figure 4G). Surface lustre a little shining (gleamy) to glossy, dull on worn specimens.

Protoconch and next two whorls are whitish or bright white, protoconch sometimes faded (Figure 2). Following whorls are lemon yellow

(Figure 5C), straw yellow (Figures 4A, 5B) or greenish yellow (Figure 4G), and whitened behind the lip on the last (Figure 5C) or not (Figures 4A, 4G), and possibly a pale brown form exists (non-type, juvenile BOR.MOL 4764). A grey or greyish-yellow suprasutural fillet on the early whorls is distinct or faded. Sutural coloration separates the two populations. Tawau District shells have an intense yellow sutural margin on the last two whorls, bordered below by a narrow white subsutural band. Semporna District shells only have a wider white band beneath the suture (infrasutural band). For both populations, the white band is distinct (Figure 4A), faint (Figure 5C) or faded-away (Figure 3B).



Figure 4. A. (A.) *c. chuai* n. ssp. from Semporna District, Sabah (not shown to same scale): A. paratype 4; B. paratype 6; C. paratype 8; D. paratype 9; E. paratype 11; F. paratype 15; G. paratype 17; and H. paratype 21 [photos: A BioPortal, 2016; B Adam J. Baldinger; and C-H Amalina Brahim].

Oblique markings start as faint, nearly straight brown lines or stripes that become ragged and darkened behind the lip. They are moderately spaced (Figure 5C), crowded (Figure 3A) or coalesced (Figure 4H), and sometimes partially interrupted by a lemon girdle (Figure 4F). Telostripe is brown like the other stripes (Figure 3B) or slate-purple (Figure 5C), occasionally connected by a basal band of the same hue, which also connects the bases of the other lines or stripes (Figure 3A). Dark-coloured morae that mark the border of a growth stoppage, like the black ones on *A. (A.) atricallosus* (Gould, 1843), are very rare and only one unstriped shell (non-type, adult BOR.MOL 4764) has a slate-purple mora c. $\frac{1}{8}$ whorl behind its lip. One patterned shell (Figure 4E) has two dark ventral stripes, which are probably not morae and resulted from random post-death elution of the pattern. Whitish circumumbilical zone (or umbilical patch) is faint to distinct.

Aperture is subovate and varies slightly in width (narrowest Figure 4C, and widest Figure 4B); weakly subeffuse basally with a slight dent beside the columella, or not dented. Palatum is dull to glimmering, with a paler hue than the exterior deep inside the aperture, and whitened toward the lip. Outer lip, columella, parietal callus and parietal tubercles all have a gleamy lustre. Outer lip and columella are white, except they are bone-coloured on one shell (Figure 5B) that also has a partially brownish-grey tinged parietal margin. Columella is hollow and distinctly twisted to almost straight. Columellar margin is dilated, adnate and generally thickly callused. Outer lip is very narrowly (Figure 2) to narrowly expanded (Figure 4B) with a flat or slightly rounded surface, and its edge bent back slightly like a rim; usually continuously thickened during maturity or distinctly doubled (Figure 5B). Residual periostracum on one shell is very pale tawny (Figure 5B). Umbilicus is usually sealed, rarely slightly open and rimate.

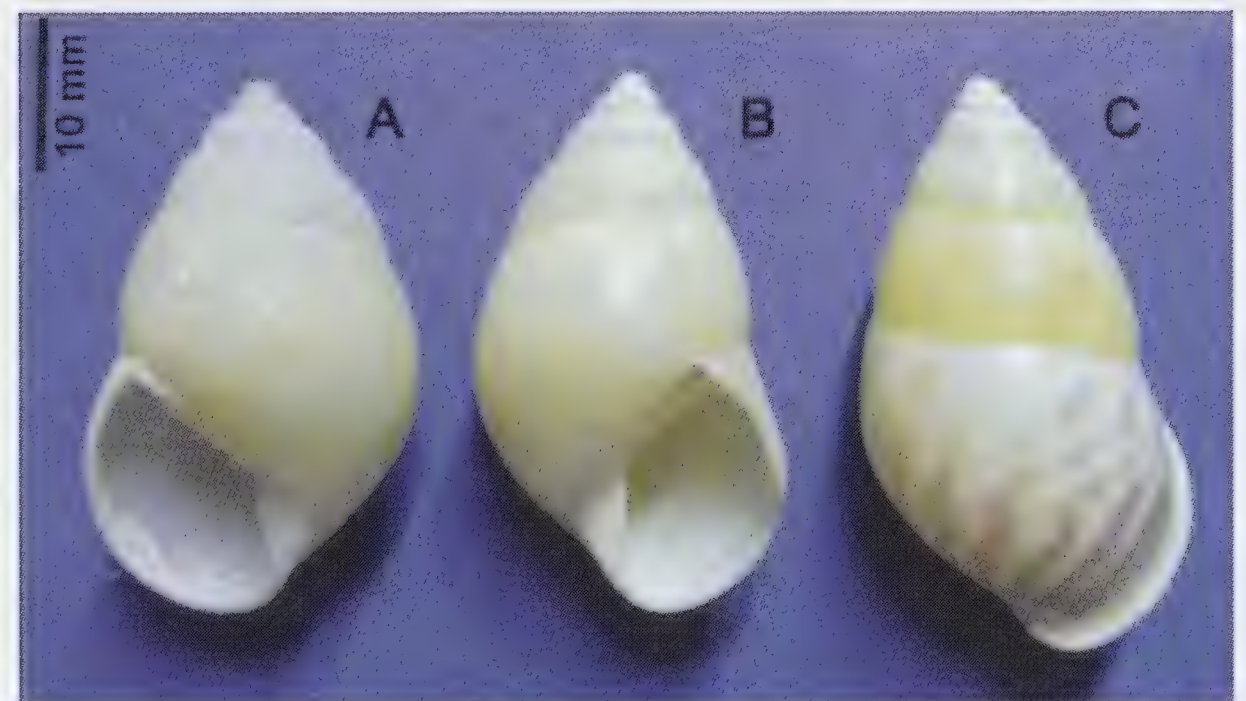


Figure 5. Variation of *A. (A.) c. chuai* n. ssp. non-type shells from Tawau District, Sabah (JP, ex-CF): **A.** ventricose shell with a deteriorated pattern, except for a few residual marks behind the lip (shell 5); **B.** narrow "patternless" shell (shell 6); and **C.** fully patterned shell (shell 7) [photos: JP].

Parietal callus is colourless or whitened and often has two white tubercles, one at each end of its margin (Figure 2), or none (Figure 3A). Parietal-labral tubercle begins as a subdeltoid smudge of callus c. 2 mm long attached to the slightly ascending lip termination (immature stage, Figure 5B). Thickening anteriorly and slightly inward, firstly forms a flattish subtriangular lump (submature stage, Figure 3B), and later a thick subpyramidal lump c. 4 mm long (mature stage, Figure 3C), sometimes elongated (Figure 5A). Parietal-columellar tubercle starts as a slight thickening of the parietal margin (immature stage, Figure 5B). Continued thickening, reduced toward its tip, forms a sickle-shaped (falcate) extension of the columellar margin c. 6 mm long (mature stage, Figure 4E). Among shells from Semporna, one fragment (non-types, BOR.MOL 4834) and one adult (Figure 4E) have a cord-like callus connecting both tubercles, which is absent in all of the Tawau shells.

Discussion.

Shell measurements from this study and the literature (Pfeiffer, 1853; Dohrn, 1889; Pilsbry, 1900; von Martens, 1903; Bartsch, 1917;

Laidlaw & Solem, 1961; Dharma, 2007 & 2012; and Sutcharit & Panha, 2011) deduced the following: *A. (A.) c. chuai* n. ssp. has small shells; *A. (A.) mundus* generally has small shells, rarely medium-sized; and small to medium-sized shells for *A. (A.) c. capistratus*, *A. (A.) entobaptus* and *A. (A.) similis*.

Although originally described as *A. (A.) martensi* var. *capistratus*, von Martens (1908) later raised it to full species status and it is accepted here as *A. (A.) c. capistratus*. However, Laidlaw & Solem (1961) considered it merely a slight colour variant of *A. (A.) martensi* Böttger, 1893 without further elaboration. Current measurements show a clear size difference between the subspecies, with *A. (A.) c. chuai* n. ssp. (H 30.79-36.21 mm) having smaller shells than *A. (A.) c. capistratus* (H 39-47 mm). Future measurements of the other material (types and non-types) of *A. (A.) c. chuai* n. ssp. may show an overlap in the size range.

All three syntypes of *A. (A.) c. capistratus* (Figure 6) are conic-ovate and having faded since collection, they are now light buff to antimony yellow (greyed orange-yellow) with paler early whorls. *A. (A.) c. chuai* n. ssp. displays four shell shapes (ovate and conic-, ventricose- or oblong-ovate), and has whitish early whorls and lemon-, straw- or greenish-yellow lower ones, the last sometimes whitened behind the lip. Both have a colourless parietal callus, except *A. (A.) c. capistratus* has weakly developed white parietal tubercles (Figures 6B-C) like submature ones seen on *A. (A.) c. chuai* n. ssp. (Figure 3B), or they are absent (Figure 6A). On the last whorl, *A. (A.) c. chuai* n. ssp. has fine to coarse plicae, often coarser on the base and weaker above the periphery, whereas *A. (A.) c. capistratus* has fine plicae on the antepenult and penult, slightly coarser on the last.

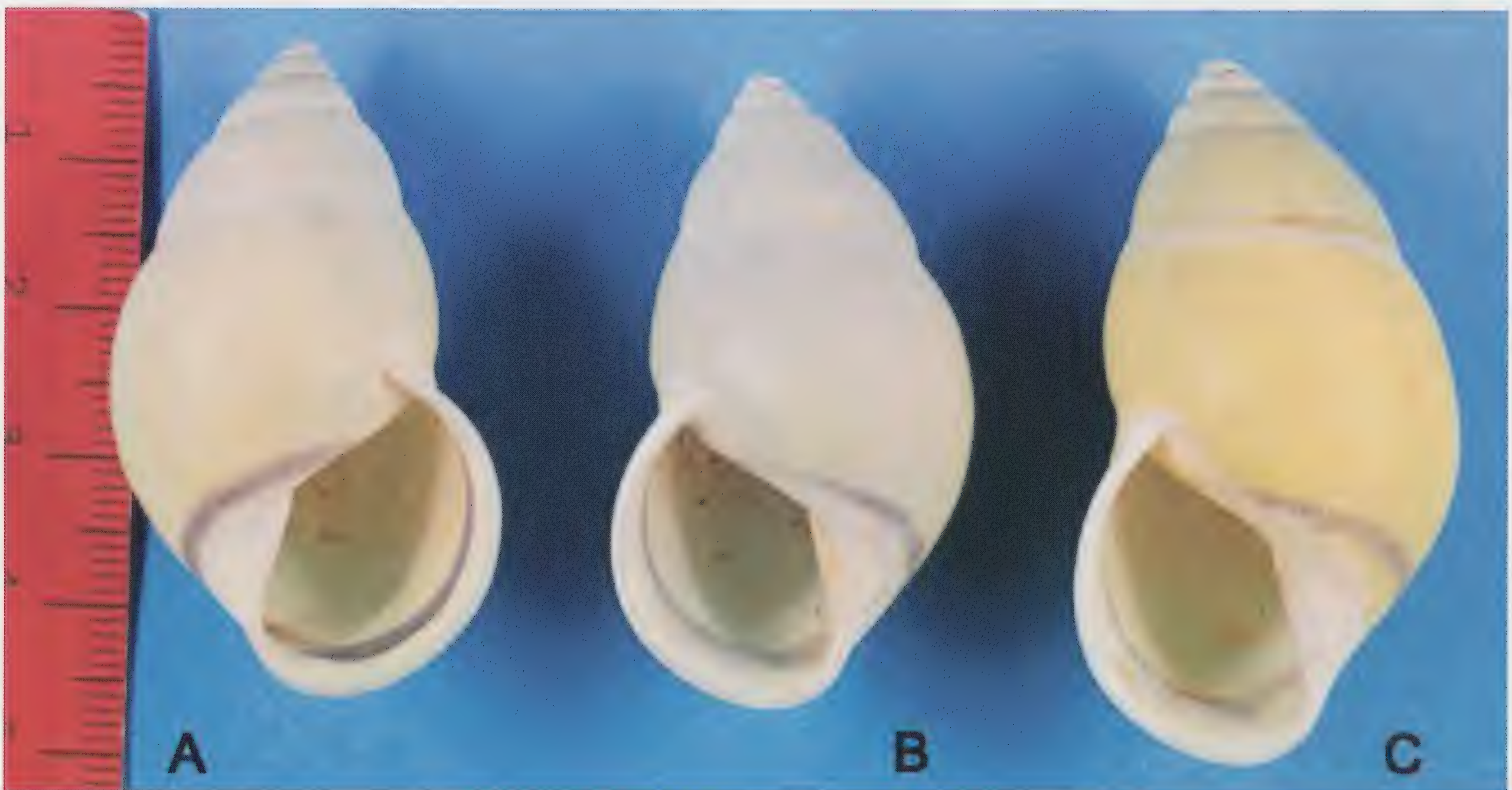


Figure 6. Nominotypical subspecies *A. (A.) c. capistratus* syntypes (MN), ZMB 59670 Sultanat Kutei, Ost-Borneo [photos: Christine Zorn].

Both subspecies are amphidromine and have a whitish umbilical patch, rounded or subangulate penult, and structurally they have the same lip, columella, aperture and protoconch. *A. (A.) c. chuai* n. ssp. very rarely has dark-coloured morae and *A. (A.) c. capistratus* lacks them. *A. (A.) c. capistratus* has a whitish subsutural band below a yellow sutural margin on the lower whorls, as seen on *A. (A.) c. chuai* n. ssp. only from Tawau. The obvious difference is in the dark pattern. *A. (A.) c. capistratus* only has two angularly connected, blackish-purple markings: a telostripe, separated from the outer lip by a gap of about twice its width, and a basal band. Patterned shells of *A. (A.) c. chuai* n. ssp. also have a telostripe, except it is dark brown or slate-purple, and just a few shells have a same-coloured basal band. Its pattern differs by the presence of paler brown stripes or lines, and many shells are “plain” and lack dark coloured markings.

There are several ways to describe the coloration of the early whorls (including protoconch) of the taxa studied here: 1) whitish or white with a grey, coloured-grey or coloured suprasutural fillet; 2) grey, coloured-grey or coloured with a whitish or white apex and infrasutural zone; or 3) whitish or white upper part and grey, coloured-grey or coloured lower part. The following shared or distinct differences with *A. (A.) c. chuai* n. ssp. are noted.

A cursory examination suggests *A. (A.) mundus* is simply a white colour form of *A. (A.) c. chuai* n. ssp., since both have amphidromine shells of similar shape and size. *A. (A.) mundus* differs in being a peninsular-Malaysian species from Pulau Besar, Johor (Sutcharit & Panha, 2011) with only albous (dull white) shells with a straight or twisted columella that is vertical and subcompressed. Its spire is shorter to slightly

longer than the aperture at 0.45-0.59 (Laidlaw & Solem, 1961; Dharma, 2007; JP).

A. (A.) entobaptus is a Philippine species with a large range in the Palawan Province; from Balabac Id. to Busuanga Id. (Dohrn, 1889; Pilsbry, 1900; Bartsch, 1917; Laidlaw & Solem, 1961). It differs in having only sinistral shells that are conic-ovate, subpyramidal-ovate or elongate-ovate. Upper part of the early whorls is white or cream, and sometimes pale yellow on yellow shells. Lower whorls have an appressed subsutural region and the aperture height is larger than the spire at 0.52-0.59 (Dohrn, 1889; Pilsbry, 1900; JP). The last whorl may be inflated (Figure 7F), or partially so (subgibbose, Figure 7G), the base is somewhat tapered to angularly rounded, and whitewashed (white suffusion) in some shells. Translucent morae uncommonly occur singly or in pairs and are grey, similar to the ground colour or whitish, and sometimes with a grey impressed resting line. The outer lip's edge is either: 1) recurved; or 2) retroflexed and firmly attached to the back of the lip (connate behind), sometimes flattened as the lip thickens and rarely partly touching the last whorl (subadnate). The acuminate columella is variable: distinctly twisted to almost straight; vertical; abapertural (Figures 7E–G) or adapertural basally (Figure 7H); and its base subreflexed dorsally to slightly ventrally.

A. (A.) similis is another Bornean species, distributed from the Sadong River Basin, southern Sarawak, Malaysia due south to the Kapuas River Basin, West Kalimantan, Indonesia. It differs in generally having dextral shells that are lemon yellow or occasionally dull white to greyish white in Sarawak. Kalimantan shells are only yellow and very rarely sinistral (Dharma, 2007). Shape is variable: squat to tall conic-ovate; subpyramidal-ovate, sometimes with a tapered spire; or ventricose-ovate. Its spire is shorter to slightly longer than the

aperture height: 0.45-0.59 (Laidlaw & Solem, 1961; Dharma, 2007; JP). Its outer lip's edge is slightly recurved and the columellar margin often has a secondary tubercle (rounded lump) on its outer corner.

A. (A.) mundus and *A. (A.) similis* both lack morae and have a medium-sized aperture with its base subeffuse or not effuse. *A. (A.) entobaptus* and *A. (A.) similis* both lack a whitish circumumbilical zone on non-white shells and the lower part of the early whorls has the following colour separation between their colour-forms: grey in white shells and coloured-grey in non-white shells.

A. (A.) mundus, *A. (A.) entobaptus* and *A. (A.) similis* all have plain imperforate shells with a finer teleoconch sculpture, non-plicate last whorl, white infrasutural band, slightly wider outer lip, and the last whorl has a shallow or indented suture with a simple or slightly irregular margin that is never yellow. However, *A. (A.) similis* may have a few brown subsutural spots (Schepman, 1896), and has a more

regularly spaced and slightly coarser transverse sculpture.

A. (A.) entobaptus contrasts with the other taxa in a number of features. It has a medium to large acuminate-oblong aperture with a non-effuse base and much larger for an equivalent shell size. The callused columellar margin expands upwards from the columella's base, whereas it expands outward from the columella's side in the other taxa. The ground colour is more variable: whitish, cream, yellow, orange-yellow or flesh-coloured and rarely white. Some colonies may have the whole shell or upper part red-, violet- or green-tinted (Hidalgo, 1897; Bartsch, 1917). The palatum is generally yellow (pale citron to ochreous-orange), and of a different tone to the exterior on yellow shells. The palatum on pale yellow shells may be pale yellow or paler deep inside and whitened toward the lip; and rarely yellowish-cream on whitish shells or white on white shells. *A. (A.) similis* contrasts with the other taxa in having a different coloured paries: purplish-brown or reddish-brown with a darker or blackish margin at full maturity.

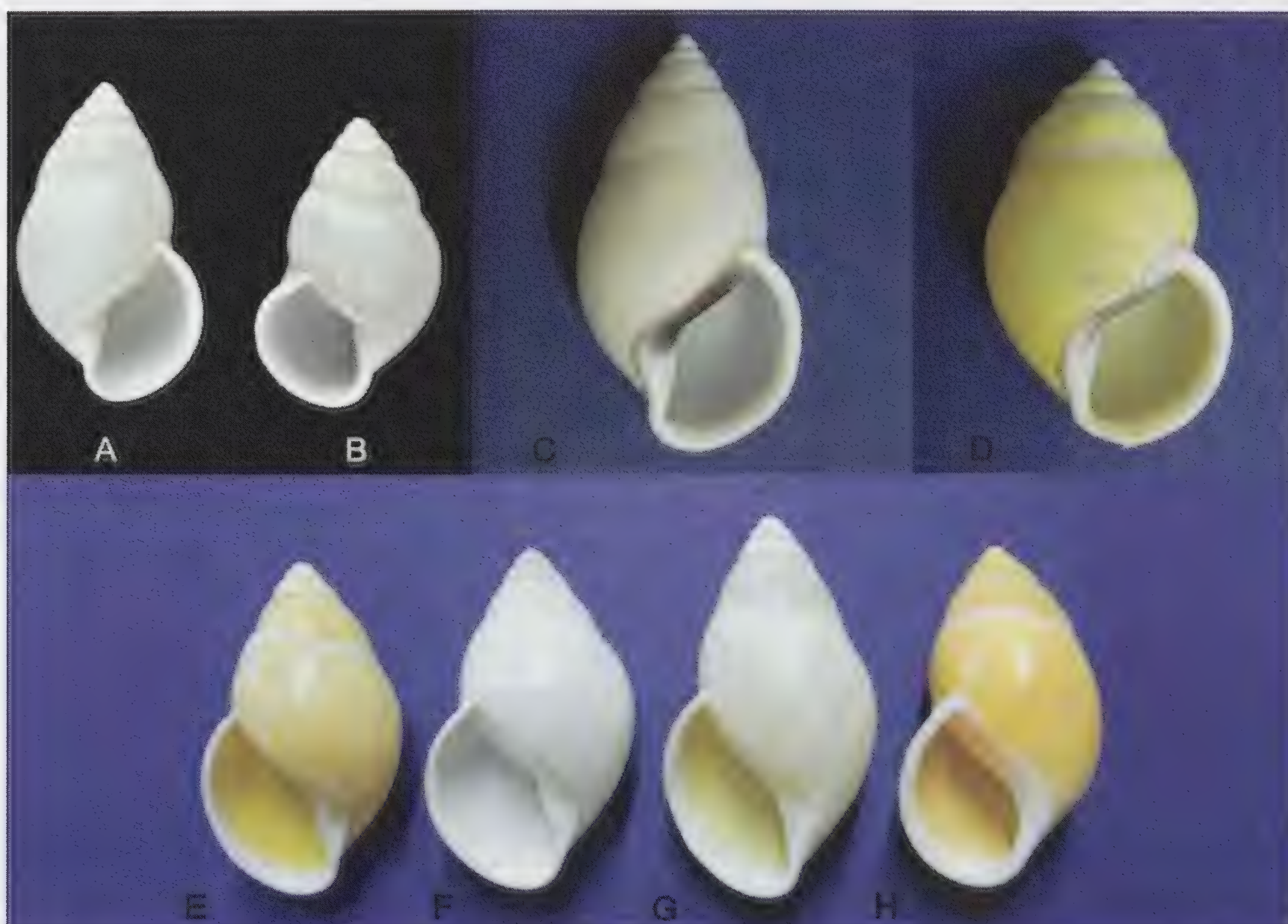


Figure 7. Nearest relatives of *A. (A.) c. chuai* n. ssp.: **A-B** *A. (A.) mundus* Pulau Besar, Johor, Malaysia, **A.** Neotype CUMZ 4917; **B.** topotype CUMZ 4914; **C-D** *A. (A.) similis* Bukit Ranchan, Serian District, Sarawak, Malaysia (JP); and **E-H** *A. (A.) entobaptus* Palawan Province, Philippines (JP): **E.** Balabac Id., **F-G** location not specified, probably Culion Id. and **H.** Bituan, Busuanga Id. [photos: **A-B** Sutcharit & Panha, 2011; and **C-H** JP].

ACKNOWLEDGMENTS

I thank Andy Tan for the loan of the types from the Chua Family, and Jonathan Ablett (Curator of Non-Marine Mollusca and Cephalopoda, Division of Invertebrates, Zoology Department, NHMUK) for assistance in depositing the holotype; and Christine Zorn (MN) for photos of the *A. (A.) capistratus* syntypes. I also thank the following people for photographs of specimens re-registered as paratypes of this new subspecies in their respective museums: Amalina Brahim (BMC), staff at NBC and Adam J. Baldinger (MCZ).

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A Putative Inter-Generic Hybrid Between *Conomurex* Fischer and *Gibberulus* Jousseaume (Gastropoda: Strombidae) from South Africa

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ABSTRACT This paper highlights a putative inter-generic *Conomurex* x *Gibberulus* hybrid from the Sodwana Bay area, North Natal, Republic of South Africa. Putative hybridisation in the Strombidae is becoming ever more recognised at the intra-generic level. Much rarer are the inter-generic hybrids. The new putative hybrid indicates that inter-generic hybridisation may well be an evolutionary force in the radiation of Strombidae, facilitating both rapid reticulation and speciation.

KEY WORDS Hybrid, Reticulation, South Africa, Stromboidea.

INTRODUCTION

Reticulation is often overlooked as a means of speciation and extinction in evolutionary thinking. Hybrids are often treated with a Darwinian conceptualisation of impotence, and therefore, evolutionary dead ends (Darwin 1850). More modern theory, while anchored in sterility, accepts productive viability in hybrids can occur, and this may lead to the formation of new species (Mayr 1963). Reticulation, or the generation of species through a process of hybridisation, has long been overlooked in families with rapid patterns of radiation in the animal kingdom (Madison and McMahon 2000). Notwithstanding there has been increasing interest in the hybridisation within the tropical marine gastropod group Strombidae (Thach 2007; Dekkers 2010; Kronenberg 2013; Liverani & Wieneke 2016).

The Strombidae are gregarious herbivorous organisms that are known to live in large mixed species aggregations giving rise to potential for hybridisation (Abbott 1960). Putative intra-generic hybridisation is well documented in Strombidae with records from *Dolomena* Wenz 1940 (or *Ministrombus*; Dekkers 2010),

Doxander Wenz 1940 (Man in 't Veld and Visser 1993), *Euprotomus* Gill 1870 (Kuroda 1942), *Lambis* Röding 1798 (Greene, 1978; De Turk *et al.* 1999), *Lentigo* Jousseaume 1886 (Kronenberg 2008), *Lobatus* Swainson 1837 (Kronenberg 2013; Liverani & Wieneke 2016) and *Sinistrombus* Bandel 2007 (Thach 2007). Inter-generic hybridisation is less reported with most falling within the *Lambis* after Abbott (1961) historical complex and not considered therefore previously as inter-generic. However, recent systematics has elevated many subgenera to genera and this taxonomic repositioning has resulted in the inter-generic hybrids: *Lambis* x *Harpago* (De Turk *et al.* 1999). More recently, further evidence for inter-generic hybridisation with the Strombidae with a *Lambis* x *Sinustrombus* reported (Kronenberg, 2008).

The increasing number of recognized hybrids in Strombidae might well reflect the selective capacities of shell tradesmen and collectors who learned to recognize the hybrids from the millions of shells that are caught each year. The herein discussed hybrid is no exception: bought by a collector and integrated into a large private Strombidae collection (of the first author) and only recently recognized as a potential hybrid,

particularly given the sympatric nature of the two hypothesised parent species (Barnard 1951; Kensley 1973; Richards 1984; Steyn and Lussi 1998).

SYSTEMATICS

Mollusca Linnaeus 1758

Caenogastropoda Cuvier 1797

Sorbeoconcha Ponder and Linberg 1987

Stromboidea Rafinesque 1815

Strombidae Rafinesque 1815

Conomurex Fischer 1884

Diagnosis. The shell of this genus is cone-shaped, with a blunted spire and a long narrow aperture. The outer lip is not dilated and runs parallel to the inner body whorl. The spire is rarely with varices.

Discussion. The genus *Conomurex* is a widely spread genus with members in the Mediterranean Sea (introduced), Indian and Pacific Oceans. There is one species known from both the Mediterranean Sea and the Indian Ocean, *C. persicus* Swainson 1821 originally described as *C. raybauldi* Nicolay & Romagn-Manoja 1983 (Alyalrinskaya 2003). The north-western Indian Ocean contains both *C. coniformis* Sowerby I 1842 and *C. decorus* Röding, 1798 (Abbott, 1960; Moolenbeek and Dekker 1993). With *C. persicus* Swainson 1821 restricted to the Red Sea (Abbott 1960). Within South Africa only *C. decorus* is known from Durban, Kosi Bay and East London (Barnard 1951; Abbott 1960; Kensley 1973; Richards 1984; Steyn and Lussi 1998).

Gibberulus Jousseaume 1888

Diagnosis. The shell of this genus is distorted and asymmetrical. Varices on the spire which tend to be broad and flattened in the south Pacific. The aperture is fusiform in shape.

Discussion. The genus *Gibberulus* contains three species: the Indian Ocean *G. gibberulus* Linnaeus 1758 (Abbott, 1960); the Red Sea *G. albus* Mörch 1850 (Abbott 1960); and the Pacific *G. gibbosus* Röding, 1798 (Abbott 1960). While these three species have historically been hypothesised as subspecies of *G. gibberulus* (Abbott, 1960), this paper considers them full species based on distinctive morphology and distribution patterns. Records from South Africa indicate that *G. gibberulus* ranges north from Durban (Barnard 1951; Kensley 1973; Richards 1984; Steyn and Lussi 1998).

Conomurex decorus Röding 1798 × *Gibberulus gibberulus* Linnaeus 1758

Description. The shell has a length of 60.6 mm and a width of 31.2 mm. The shell is solid and heavy for the size with a flaring but recurved outer lip. The body whorl is smooth with a rounded shoulder and smooth with small growth and spiral lines towards the outer lip. The spire is moderately high, not shouldered on early whorls and with regular varices that are placed at 120°. The shell is dorsally depressed with asymmetrical whorls and a ventro-dorsal height of 23.5 mm. The columella is thickened and is off-white in colouration. Posterior sinus well developed and not reaching the penultimate whorl. The stromboid notch is well developed. The anterior canal is short and ovate. Aperture and labrum smooth except for fine lirae basally around the stromboid notch. The dorsal colouration is a white-cream ground colour scantily decorated by brown chevron like streaks that are seemingly arranged in spiral

bands. The inner aperture has an orange colouration. The operculum is brown with 8 serrations. The specimen was collected by Alan Secombe, diving in 10m in the Sodwana Bay area, Natal north coast, Taken Republic of South.

Discussion. The putative hybrid shared characteristics unique to each of its hypothesised parents (Figure 1, Table 1). Of particular note is the shape and coiling of the whorls leading to an irregularly depressed body typical in form to *Gibberulus*. In contrast, there are distinctive characteristics like the colour and decoration of the aperture, the overall shell colour and the strombid notch are typical for members of *Conomurex*.

CONCLUSION

The role of hybridisation in the evolutionary processes of reticulation and speciation are often over looked. However, as more hybrids are discovered and the extent and limitations of hybridisation in the Strombidae are explored, there will be a need to reconsider the validity of names attributed to hybrids that may now represent stable populations. This is particularly the case with the *Lambis*. The new putative hybrid highlights the need to explore and determine the limitations of hybridisation. Knowing these limitations might inform on fossil systematics providing insights to the rapid rise of novel taxa.

ACKNOWLEDGEMENTS

The authors thank Henk Dekker, of Winkel, the Netherlands, for his continuous support.

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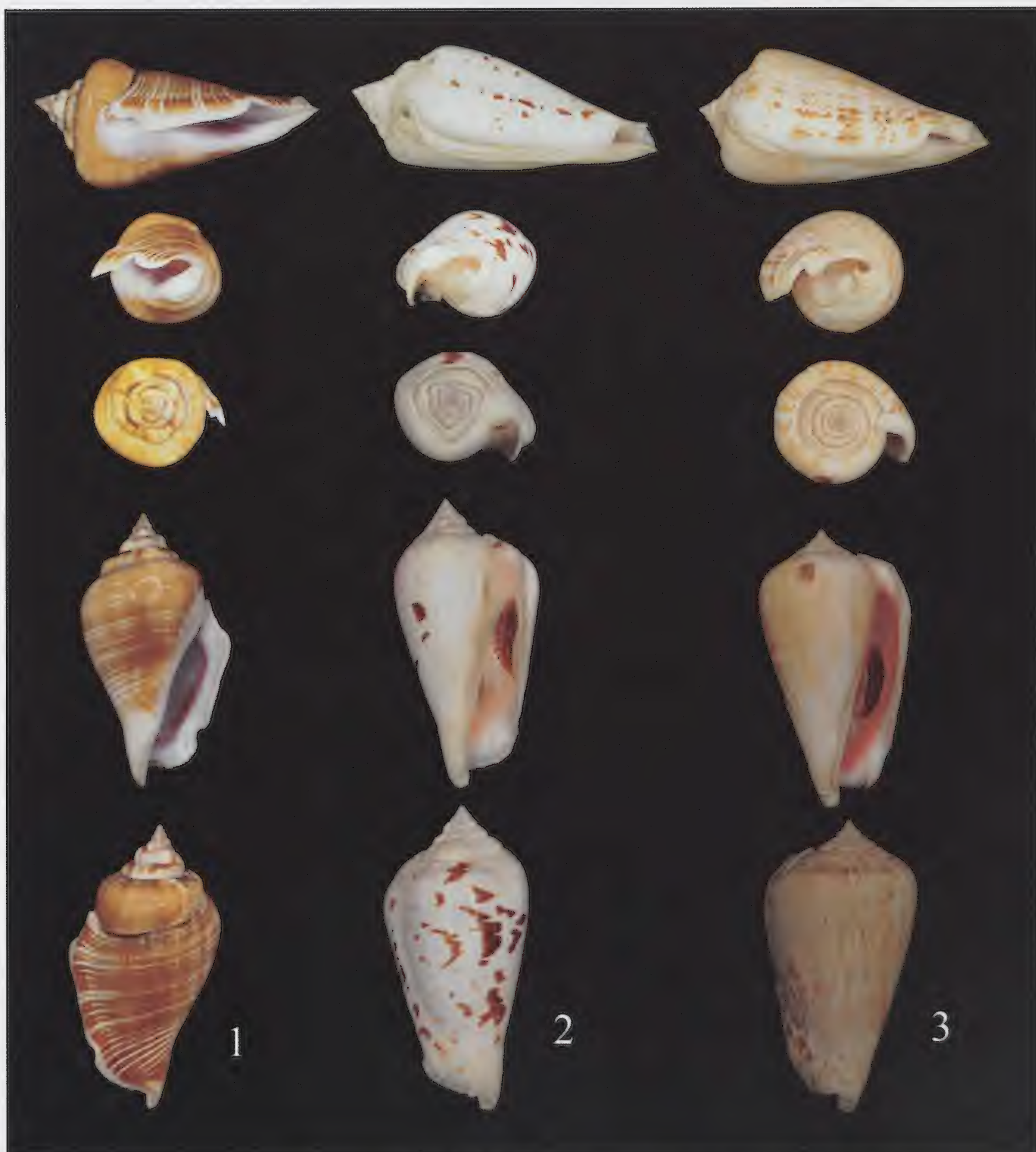


Plate 1. Figure 1 = *Gibberulus gibberulus* Linnaeus 1758, Inhaca Island, Maputo Bay, South Mozambique. Snorkling 2-3 m. on sandy mud in sea grass. Length 45.5 mm. AMD STR3073. Figure 2 = *Conomurex decorus* Röding 1798 × *Gibberulus gibberulus* Linnaeus 1758, Natal north coast, Sodwana area, RSA. Dived in 10 m, 2009, Length 60.6 mm. AMD STR1639. Figure 3 = *Conomurex decorus* Röding 1798, Natal, RSA. On sand flats at low tide, 1969. Length 57.3 mm. AMD STR0490.

Character	<i>Conomurex decorus</i>	hybrid	<i>Gibberulus gibberulus</i>
Size (Length)	30 - 70 mm	60.6 mm	30 -70 mm
Shell	Heavy and solid	Heavy and solid	Heavy and solid
Number of whorls	9 to 10	9 to 10	10
Spire	Spire depressed, coronated at first becoming less so with development, deep sutural groove, strongly shouldered at the commencement of the body whorl, no old varices.	Spire medium tall, early whorls with regular varices at 120°, deep suture as a groove, body whorl with round shoulder.	Spire moderate tall , with broad swollen former varices which are crossed by 6 to 8 spiral threads. The varices are sometimes more or less placed at 180° and sometimes regularly go at 120° . Often the pre-ultimate whorl very swollen.
Form of shell whorls seen from apex	Round	Depressed	Depressed
Aperture decoration	Smooth, often with small striae near the strombid notch.	Smooth, with small striae near the strombid notch.	Lirae on the full length of the labrum.
Aperture colour	White with light orange interior of labrum with white border.	White with orange interior of labrum with white border.	White-cream with on the inside tinted purplish to violet.
Stromboid notch	Small, deeper than width	Smaller and deeper	Broader than depth
Anterior canal	Small and high	Roundish	Broader than high
Colour dorsum	Basic colour white to cream. Body whorl with several variable bands of irregular light brown flecks.	Cream white with streaks forming chevron like signs, vaguely in bands.	Basic colour dark cream to light brown with brown bands and flecks.
Posterior sinus and canal	Shallow and not very thickened sinus, ending in a small posterior canal. Almost reaching previous whorl.	Well visible posterior sinus, ending in a small anterior canal. Not reaching previous whorl.	Posterior sinus is a hooked edge towards a deep posterior canal.
Serrations on operculum	6 to 7	8	7 to 8

Table 1. Comparison of *Conomurex decorus* Linnaeus 1758, and *Gibberulus gibberulus* (Linnaeus, 1758) and the putative hybrid specimen.

A New *Lautoconus* Species Radiation from Gambia, West Africa

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ABSTRACT Six sympatric species of the cone shell genus *Lautoconus* Monterosato, 1923 have been discovered on an isolated rock reef near the Gambia River Mouth, Gambia, West Africa. Of these, four were found to be new to science and, together, they represent a previously unknown Gambian endemic species radiation. These include: *Lautoconus fernandi* new species, *L. gambiensis* new species, *L. rikae* new species, and *L. wolof* new species. The poorly-known Gambian endemic cone, *Lautoconus orri* (Ninomiya and da Motta, 1982) was also found to be a component of the rock reef fauna, as was the wide-ranging *L. guinaicus* (Hwass, 1792) (Senegal to Ghana). The Gambian cluster of sibling species represents the farthest-south separate radiation of *Lautoconus* known from the West African coast.

KEY WORDS Gambia, West Africa, Cone Shells, Conidae, *Lautoconus*.

INTRODUCTION

In early 2018, the well-known Belgian malacologists and shell dealers Fernand De Donder and Rika Goethaels initiated one of the first thorough investigations of the molluscan fauna of Gambia and the Gambia River Mouth, West Africa. During this research and collecting trip, they worked with the local fishermen, who saved deeper water shells for them, and conducted intensive surveys of the intertidal sand flats, mud banks, and rocky reef platforms along the entire Gambian coast. All of these environments proved to house rich molluscan assemblages, most of which contained rarely-seen and poorly-known species, many of them “lost” since their original descriptions. One of these habitats, a rocky reef-like platform covered with *Enteromorpha* and *Ulva* green algae (Figure 1), was visited during an unusually low tide. This rocky area, which is normally flooded with a meter of water, was found to contain a previously-unknown cone

shell fauna, comprising six species of the genus *Lautoconus* Monterosato, 1923. Previously, West African ecosystems with large numbers of sympatric *Lautoconus* species were known only from Senegal, especially the areas along the Cape Verde Peninsula and the Petit Cote (Monteiro, Tenorio, and Poppe, 2004; Abalde, *et al.*, 2017). The discovery of a new Gambian species radiation demonstrates that conid “evolutionary hot spots” extend farther south along this coast than was originally thought.

The algae-covered rock reef that De Donder and Goethaels discovered extended along the sandy beach line off Tanji, south of the Gambia River Mouth. The local water conditions were murky due to suspended sediments and phytoplankton blooms, the result of the nutrient-rich effluent from the nearby Gambia River. The high concentration of dissolved nutrients has resulted in extensive eutrophication, as evidenced by the thick growths of the green algae *Enteromorpha* and *Ulva* that carpeted the rock reef. These

eutrophic water conditions also would support an immense polychaete worm population, the perfect food resource for a diverse fauna of the vermivorous cone shell genus *Lautoconus*. In this area with the huge polychaete biomass, the Belgian explorers collected over four hundred specimens comprising two previously-described cones and four that were completely new to science. The two known taxa included the large-shelled *Lautoconus guinaicus* (Hwass, 1792), which ranges from the Cape Verde Peninsula of northern Senegal south to Ghana, and the smaller *L. orri* (Ninomiya and da Motta, 1982) (Figure 3 G, H), which is endemic to the area of the Gambia River Mouth (author's note: the triangular and flat-topped *L. orri* has often been incorrectly synonymized with the Senegalese *L. mercator* (Linnaeus, 1758), which is found only along the western edge of the Cape Verde Peninsula; the two congeners are now known to be distinct). These two known species, *L. guinaicus* and *L. orri*, were found to be fairly common on the Tanji rock reef.

In addition to the known species, an endemic species radiation, comprising four new *Lautoconus* species, was also discovered to inhabit the Tanji reef. We here propose that these new taxa have become reproductively isolated from their Senegalese relatives to the north and have evolved into a new cluster of siblings; the result of a barrier formed by the wide area of open sand beaches and lack of suitable habitats along the Petit Cote to the north. The Tanji rock reef, with its rich polychaete worm fauna, acted as an island and refugium for any cone shell migrants, allowing them to evolve in isolation and form their own cluster of species. Through the kindness of Rika Goethaels the authors were able to examine over fifty macro photographs of each new species together with measurements. In the absence of anatomical and genetic data, we here describe *L. fernandi*, *L. gambiensis*, *L. rikae*,

and *L. wolof*., as morphospecies in the following sections. The holotypes are deposited in the National Museum of Natural History, Paris, France and bear MNHN catalog numbers.

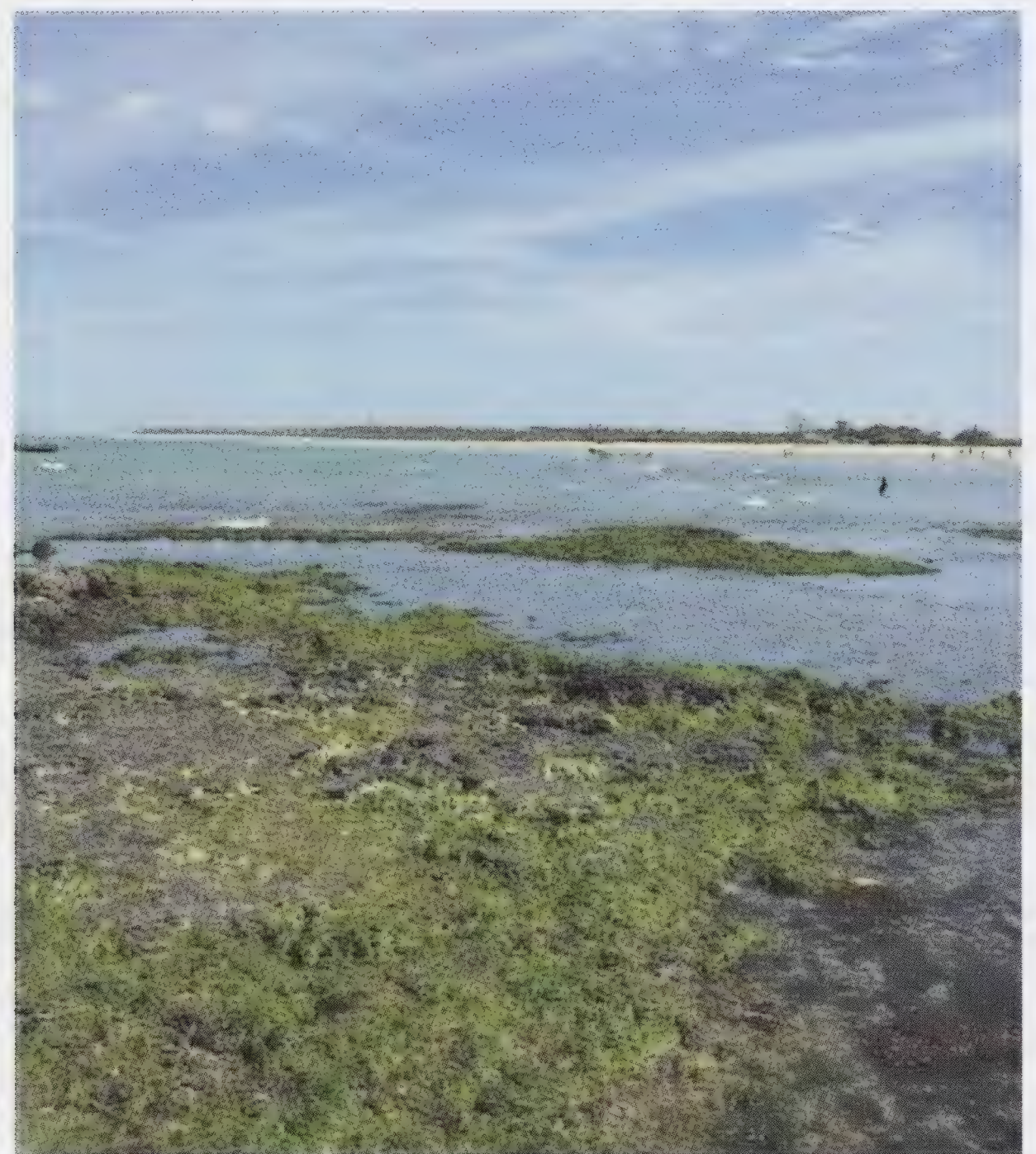


Figure 1. View of the type locality of *Lautoconus fernandi*, *L. gambiensis*, *L. rikae*, and *L. wolof*, off Tanji Beach, Gambia. Note that the exposed rock reef (during an extreme low tide) is covered with the eutrophic-loving green algae *Enteromorpha* and *Ulva*. The four new cone species, along with *Lautoconus orri* and *L. guinaicus*, were found among rubble and in crevices covered by the algal growths.

SYSTEMATICS

Class Gastropoda

Subclass Sorbeoconcha

Order Prosobranchia

Infraorder Neogastropoda

Superfamily Conoidea

Family Conidae

Subfamily Puncticulinae

Genus *Lautoconus* Monterosato, 1923

Lautoconus fernandi Petuch and Berschauer,
new species
(Figure 2 A, B)

Description. Shell large for genus, averaging around 38 mm, elongated, fusiform, narrow, with high pyramidal spire whorls; shoulder distinctly rounded, forming wide, broad carina-like flange; subsutural area concave, forming slightly canaliculate spire whorls; body whorl smooth with silky texture, with anterior end being encircled with 10-12 small, low spiral cords; sutural channel of spire whorls ornamented with 2 very fine incised spiral threads; shell color variable, usually dark blackish-brown, with 3 wide bands of small triangular tent-shaped spots, with one around shoulder, one posterior of mid-body line, and one just anterior of mid-body line; anterior tip colored pale orange-tan or orange; spire whorls colored dark blackish-brown with very numerous, closely-packed white crescent-shaped flammules; white crescent flammules intersect depressed area of channeled suture; some specimens pale sky blue with 3 wide black bands, overlaid with continuous network of tiny black tent markings; aperture uniformly narrow, dark purple with 2 narrow white bands; periostracum thin, smooth, translucent.

Type Material. HOLOTYPE - length 35.4 mm, width 19.4 mm, at low tide on an algae-covered rock platform, Tanji, Gambia, MNHN IM-2000-34012; OTHER MATERIAL EXAMINED - 2 specimens, lengths 36.15 mm and 21 mm, same locality as the holotype, in the De Donder-Goethaels Collection, Peutie-Vilvoorde, Belgium: 3 specimens, lengths 35.2 mm, 36.0 mm, and 37.1 mm, same locality as the holotype, the research collection of the senior author; 3 specimens, 35.4 mm, 30.2 mm, and 26.1 mm, same locality as the holotype, in the research collection of the junior author.

Type Locality. Found exposed at extreme low tide, on a rocky reef covered with dense growths of the green algae, off Tanji Beach, Gambia.

Distribution. Known only from the rock reefs near the mouth of the Gambia River, Gambia.

Ecology. The new species was found, exposed at low tide, in small pockets on an eroded sandstone rock platform, covered with dense growths of the green algae *Enteromorpha* and *Ulva* (Figure 1). Here, *Lautoconus fernandi* most probably feeds on the small polychaete worms that are so abundant in the nutrient-rich sediments at the mouth of the Gambia River.

Etymology. Named for Fernand De Donder of Peutie-Vilvoorde, Belgium, who collected the type material of the new *Lautoconus* species while collecting in Gambia and who has made many important contributions to our knowledge of the West African malacofauna.

Discussion. With its large fusiform shell and high spire, *Lautoconus fernandi* most closely resembles *L. trencarti* (Nolf and Verstraeten, 2008) from the Petit Cote of northern Senegal, particularly in the area near Somone. The new Gambian species differs from its Senegalese congener in having a distinctly wider and less-sloping shoulder area and in having the characteristic shallow subsutural channel and slightly canaliculate spire whorls. Although both species often exhibit dark blackish-brown color forms, the dotted color pattern and tent markings on dark *L. trencarti* are much finer and better defined than those of dark forms of *L. fernandi*, which are more diffuse and have a blurred appearance. *Lautoconus trencarti* also lacks the prominent and distinctive crescent-shaped white markings that dominate the spire whorls of *L. fernandi*.

Lautoconus gambiensis Petuch and Berschauer,
new species
(Figure 2 C, D, E)

Description. Shell of average size for genus, around 25 mm, narrow, elongated, distinctly fusiform, with high pyramidal spire and sloping spire whorls; shoulder slightly-angled, forming wide rounded, carina-like ridge; subsutural area slightly depressed, forming wide, shallow channel; channeled suture of shoulder and spire whorls ornamented with 4 large, prominent spiral cords; body whorl smooth and silky, with anterior tip being encircled with 6-8 low, widely-separated spiral cords; shell base color bright olive-green or khaki-green, overlaid with very numerous fine pale brown longitudinal hairlines; some specimens with small, widely-scattered amorphous white flammules on posterior half of body whorl; prominent, narrow solid white band present just anterior of mid-body line; white mid-body band often marked with small, very fine pale brown flammules and rows of dots; spire whorls olive-green, marked with closely-packed narrow, amorphous bluish-white or pale green flammules; aperture uniformly narrow, deep purple-brown within interior, with one thin white band; periostracum thin, smooth, translucent.

Type Material. HOLOTYPE - length 21.6 mm, width 11.5 mm, at low tide on an algae-covered rock platform, Tanji, Gambia, MNHN IM-2000-34013; OTHER MATERIAL EXAMINED - 2 specimens, lengths 22 mm and 20.5 mm, from the same locality as the holotype, in the De Donder-Goethaels collection, Peutie-Vilvoorde, Belgium; 3 specimens, lengths 22.0 mm, 26.3 mm, and 33.1 mm, from the same locality as the holotype, in the research collection of the senior author; 3 specimens, lengths 27.2 mm, 21.7 mm, and 20.3 mm, from the same locality as the holotype, in the research collection of the junior author.

Type Locality. Found exposed at extreme low tide, on a rocky reef covered with dense growths of the green algae, off Tanji Beach, Gambia.

Distribution. Known only from the rock reefs near the mouth of the Gambia River, Gambia.

Ecology. The new species was found, exposed at low tide, in small pockets on an eroded sandstone rock platform, covered with dense growths of the green algae *Enteromorpha* and *Ulva* (Figure 1). Here, *Lautoconus gambiensis* most probably feeds on the small polychaete worms that are so abundant in the nutrient-rich sediments at the mouth of the Gambia River.

Etymology. Named for the West African country of Gambia, to which this new species is endemic.

Discussion. With its fusiform narrow shape and high spire, *Lautoconus gambiensis* most closely resembles *L. senegalensis* Gulden, Moolenbeek, and Guld, 2017 from the Ndayane area of the Petit Cote of northern Senegal. The new Gambian species differs from its Senegalese congener in being proportionally wider across the shoulder, in having distinctly channeled shoulder whorls that are sculpted with four large, heavy spiral cords, and in having a proportionally higher spire with more protruding whorls. The shell colors are also very different between the two similarly-shaped shells, with *L. gambiensis* being an almost solid olive-green or khaki-green shell with scattered fine brown lines, while *L. senegalensis* is a pale sky-blue shell or blue shell that is copiously covered with a dense network of dark brown zig-zag flammules and numerous small brown dots, often aligned in two broad bands.



Figure 2. Gambian Cone Shells: *Lautoconus fernandi* and *Lautoconus gambiensis*

A, B= *Lautoconus fernandi* Petuch and Berschauer, new species, holotype, length 35.4 mm, MNHN IM-2000-34012; **C, D= *Lautoconus gambiensis*** Petuch and Berschauer, new species, holotype, length 21.6 mm, MNHN IM-2000-34013; **E = *L. gambiensis*** Petuch and Berschauer, new species, length 20.4 mm, in the collection of the junior author; **F, G= *Lautoconus guinaicus*** (Hwass, 1792), length 35.0 mm. All specimens were collected on the algae-covered rock platform off Tanji Beach, Gambia.

Lautoconus rikae Petuch and Berschauer, new
species

(Figure 3 A, B, C)

Description. Shell of average size for genus, around 24 mm, stocky, slightly turbate, wide across shoulder, with low, domed, subpyramidal spire whorls; shoulder slightly angled, with sloping subsutural areas; body whorl smooth and silky, with 12-14 thin, closely-packed spiral cords encircling anterior end; shell color varying from solid blackish-brown to dark greenish-brown, with lighter bands present around shoulder and mid-body; large, widely-scattered amorphous pure white patches often scattered around body whorl; anterior tip pale orange-brown; spire whorls black or very dark brown, marked with widely-scattered large amorphous white patches; aperture uniformly narrow, deep purple within, marked with 2 thin white bands, one at posterior end and one at center; periostracum thin, smooth, translucent.

Type Material. HOLOTYPE - length 17.9 mm, width 9.8 mm, at low tide on an algae-covered rock platform, Tanji, Gambia, MNHN IM-2000-34014; OTHER MATERIAL EXAMINED - 2 specimens, lengths 23.4 mm and 21.2 mm, in the De Donder-Goethaels collection, Peutie-Vilvoorde, Belgium; 3 specimens, lengths 23.2 mm, 25.0 mm, and 26.1 mm, same locality as the holotype, in the research collection of the senior author; 3 specimens, lengths 23.6 mm, 24.3 mm, and 19.5 mm, same locality as the holotype, in the research collection of the junior author.

Type Locality. Found exposed at extreme low tide, on a rocky reef covered with dense growths of the green algae, off Tanji Beach, Gambia.

Distribution. Known only from the rock reefs near the mouth of the Gambia River, Gambia.

Ecology. The new species was found, exposed at low tide, in small pockets on an eroded sandstone rock platform, covered with dense growths of the green algae *Enteromorpha* and *Ulva* (Figure 1). Here, *Lautoconus rikae* most probably feeds on small polychaete worms that are abundant in the nutrient-rich sediments at the mouth of the Gambia River.

Etymology. Named for Rika Goethaels of Peutie-Vilvoorde, Belgium, who, along with Fernand De Donder, collected the type material of the four new species and who has greatly contributed to our knowledge of the mollusks of Gambia and West Africa.

Discussion. With its stocky, rotund shape, broad shoulder width, and low spire, *Lautoconus rikae* is similar only to the sympatric Gambian endemic, *Lautoconus orri* (Ninomiya and da Motta, 1982) (Figure 3 G, H). The new Gambian species differs from its sympatric congener in having a proportionally higher spire with more pyramidal-shaped whorls, in having a distinctly rounded shoulder with a more sloping subsutural area, and in being a more slender shell that is not as triangular and wide across the shoulder. *Lautoconus rikae* also differs from *L. orri* in being a much more darkly-colored shell, being mostly solid dark brown, blackish-brown, or dark khaki, and lacking a complex netted pattern, having, instead, scattered large white flammules.

Lautoconus wolof Petuch and Berschauer, new
species

(Figure 3 D, E, F)

Description. Shell of average size for genus, around 23 mm, stocky, rotund, turbate, wide across shoulder, with broadly subpyramidal spire; shoulder angled, with subsutural area sloping; body whorl smooth and silky, with 12

thin spiral cords encircling anterior end; spire whorls sculptured with 4 very fine spiral cords; base shell color dark blue or bluish-green, overlaid with variable amounts of large dark brown or black amorphous longitudinal flammules, most often arranged in 2 wide bands, one around mid-body and one around anterior end; 10-12 spiral rows of dots and dashes present on some specimens, being most prominent on blue areas of body whorl; aperture uniformly narrow, dark purple-black within interior, with 2 thin white bands present; periostracum thin, smooth, translucent.

Type Material. HOLOTYPE - length 21.1 mm, width 12.0 mm, at low tide on an algae-covered rock platform, Tanji, Gambia, MNHN IM-2000-34015; OTHER MATERIAL EXAMINED - 2 specimens, lengths 21.0 mm and 18.8 mm, from the same locality as the holotype, in the De Donder-Goethaels collection, Peutie-Vilvoorde, Belgium; specimens, lengths 19.0 mm, 21.1 mm, and 22.0 mm, from the same locality as the holotype, in the research Collection of the senior author; 2 specimens, lengths 26.4 mm, and 23.9 mm, same locality as the holotype, in the research collection of the junior author.

Type Locality. Found exposed at extreme low tide, on a rocky reef covered with dense growths of the green algae, off Tanji Beach, Gambia.

Distribution. Known only from the rock reefs near the mouth of the Gambia River, Gambia.

Ecology. The new species was found, exposed at low tide, in small pockets on an eroded sandstone rock platform, covered with dense growths of the green algae *Enteromorpha* and *Ulva* (Figure 1). Here, *Lautoconus wolof* most probably feeds on small polychaete worms that are abundant in the nutrient-rich sediments at the mouth of the Gambia River.

Etymology. The taxon, proposed as a noun in apposition, honors the Wolof people, and the Wolof Language, of Senegal and Gambia.

Discussion. Of the known West African *Lautoconus* species, *L. wolof* is most similar, in shape and general form of the color pattern, to *L. pineaui* (Pin and Tack, 1989), from the Popenguine area in the Petit Cote region of Senegal. The new Gambian endemic species differs from its northern congener in being consistently a smaller and more slender shell, in having a narrower shoulder area that is less angled, in having a proportionally higher spire with more sloping spire whorls, and in being a much more darkly-colored shell, having closely-packed dark brown or black longitudinal flammules and spiral rows of dots and dashes on a dark blue background. The Senegalese *L. pineaui* is a much lighter-colored shell, most often having a pale pinkish-tan or pale blue base color overlaid with widely-scattered large reddish-brown flammules. In having the blue base color, spiral rows of dots and dashes, and large black flammules on the spire whorls, *L. wolof* also resembles *L. echinophilus* (Petuch, 1975) from sea urchin beds in the N'Gor region of the Cape Verde Peninsula, Senegal. The new Gambian cone differs from its urchin-dwelling northern congener in being a larger, broader, and more inflated species, in having a better-defined and angled shoulder, and in having larger, darker, and more numerous color patches on the spire whorls. The ecologies of the two congeners also differ greatly, with *L. wolof* living on an algae-covered rock platform in quiet water conditions, while *L. echinophilus* lives under rock-boring sea urchins in high surf areas along the open coast (see Petuch, 1975 for a description of the ecology of *L. echinophilus*).



Figure 3. Gambian Cone Shells: *Lautoconus rikaе*, *Lautoconus wolof*, and *Lautoconus orri*.

A, B = *Lautoconus rikaе* Petuch and Berschauer, new species, holotype, length 17.9 mm, MNHN IM-2000-34014; C = *L. rikaе* Petuch and Berschauer, new species, length 19.6 mm in the collection of the junior author; D, E = *Lautoconus wolof* Petuch and Berschauer, new species, holotype, length 21.1 mm, MNHN IM-2000-34015; F = *L. wolof* Petuch and Berschauer, new species, length 26.7 mm in the collection of the junior author; G, H = *Lautoconus orri* (Ninomiya and da, Motta, 1982) length 29.1 mm in the collection of the junior author. All specimens were collected on the algae-covered rock platform off Tanji Beach, Gambia.

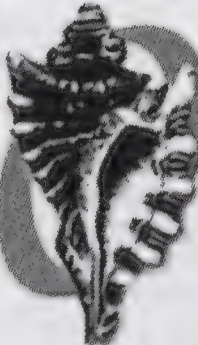
ACKNOWLEDGMENTS

For the donation of multiple study specimens, macrophotographic images and measurements of hundreds of specimens, for the collection of type material of the new species, and for sharing information about the marine environments of Gambia, we thank Fernand De Donder and Rika Goethaels; without their generosity and kindness, this paper would never have come to fruition. We also thank our reviews for their thorough consideration of the manuscript.

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Further Additions to the Knowledge of the Reproduction of *Zonaria pyrum insularum* var. *nigromarginata* (Deprez & Govaert 2009) in the Atlantic and Western Mediterranean Coast of Spain

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ABSTRACT The family Cypraeidae is represented in the Mediterranean Sea by four native species: *Luria l. lurida*; *Naria s. spurca*; *Schilderia a. achatidea*; and *Zonaria p. pyrum*. These species also inhabit the Atlantic coasts of Europe and Africa beyond the Strait of Gibraltar. Besides these, there are a few Lessepsian immigrants found occasionally throughout the central and eastern part of the *Mare Nostrum* including *Naria turdus* var. *micheloi* and *Purpuradusta gracilis notata*. This article focuses on the subspecies of *Z. pyrum insularum* (Schilder, 1928); var. *nigromarginata* (Deprez & Govaert, 2009), whose populations in the Atlantic have recently been the subject of numerous notes and comprehensive revisions (Goutal, 2008, Bergonzoni, 2013).

KEY WORDS Cypraeidae, *Zonaria*, *Zonaria pyrum insularum* var. *nigromarginata*.

INTRODUCTION

About the taxonomic status of *Zonaria pyrum*.

The most recent work on this popular group of gastropods written by Lorenz, 2017 does not elaborate on the taxonomic rank of the nominal subspecies of *Z. p. pyrum* (Gmelin, 1791) whereas the classic West African subspecies *Z. pyrum insularum* (Schilder, 1928) has been split in two distinct variations: *Z. p. insularum* var. *senegalensis* (Schilder, 1928), typically found from Mauritania to Northern Senegal and *Z. p. insularum* var. *nigromarginata* (Deprez & Govaert, 2009) from the Atlantic coasts of Portugal and Spain. However, according to our knowledge, *Z. p. insularum* var. *nigromarginata* has not previously been reported from the Mediterranean Sea.

***Zonaria pyrum insularum* var. *nigromarginata* in the Mediterranean.** The distribution of *Z. p. insularum* var. *nigromarginata* along the Atlantic coast of Portugal and Spain has been known for some time but its range must be revised, in the author's opinion, to include the adjacent coast of the Mediterranean Sea between Spain and Morocco. This biogeographical region is better known as the Alboran Sea and extends approximately 200 kilometers east to the Strait of Gibraltar. Specimens from Mediterranean populations obtained in this vast area may show some of the features typically found in the Atlantic (see Figure 1).

The specimen illustrated in Figure 2 was observed under a small piece of metal on the sea floor at a depth of 12 meters in July 2008 in the province of Granada (Andalusia, Southeast Spain) by the underwater photographer and

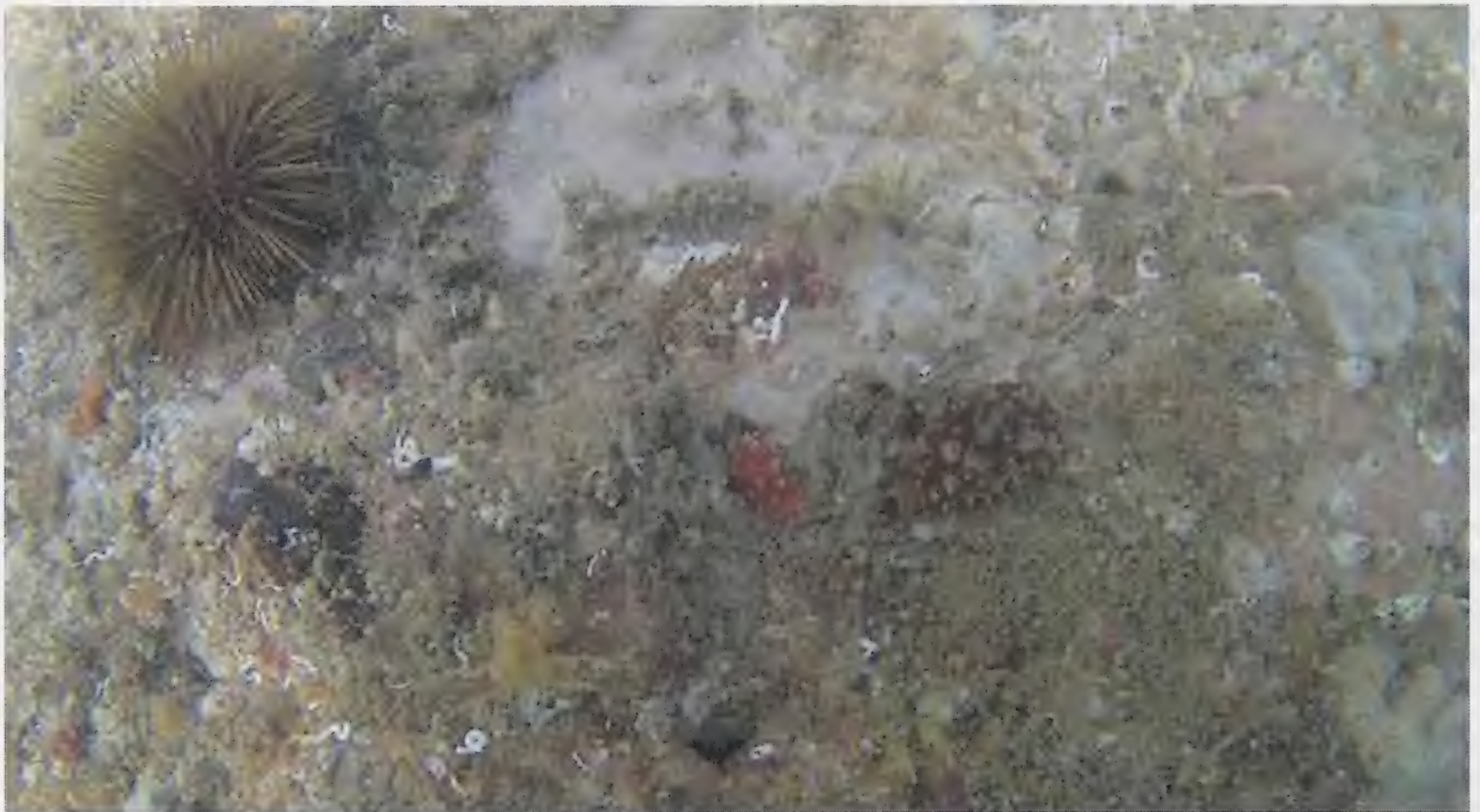


Figure 1. *Zonaria pyrum insularum* var. *nigromarginata*. Live. Atlantic coast. Spain. 2016.



Figure 2. *Zonaria pyrum insularum* var. *nigromarginata*. Live. Atlantic coast. Spain. 2006.

diver Antonio Rodríguez-Medel, who kindly allowed the author to publish his photographs in this article. A more detailed examination of this material allowed the author to identify some distinguishing features of this variation for comparison with shells found in the Atlantic populations. The cowry in Figure 2 is a female brooding an egg-mass (this animal was not disturbed during or collected after taking these photographs). As far as the author currently knows, this is not a unique report of this particular variation in this province; more recently, at least one other female specimen with eggs was reported at a depth 16 meters inside a dead spiny oyster shell of *Spondylus gaederopus* (Linnaeus, 1758) by our friend, colleague and veteran diver Francisco Esteban Ortega during the summer of 2016. The author has learned that this cowry is not common in the area, even though suitable areas with sponges where *Luria l. lurida* (Linnaeus, 1758) and *Naria s. spurca* (Linnaeus, 1758) normally inhabit are relatively abundant.

Notes on the reproduction of *Zonaria pyrum insularum* var. *Nigromarginata*. It is worth noting that in the family Cypraeidae, the habit of spawning their egg-mass inside the shell of a dead bivalve and even under artificial structures (shipwrecks and sunken platforms, and broken pipelines) in moderately or highly altered areas is a common and well known behavior after mating and it has been recorded in many members of this family throughout their distribution. In Angola, for instance, the related species *Zonaria angolensis* (Odhner, 1923) spends about eleven months in an unknown habitat, before gathering in August near Luanda in Mussulo Bay (approximately 10 kilometers south of Luanda in a place called Corimba) at depths of about 15 to 18 meters on an area of 50 to 100 square meters covered by empty shells of the bivalve *Anadara gessei* (Dunker in Kobelt, 1891) and *Pinna* sp. where they lay their eggs

(Lepetit, 1989). Similarly, female *Barycypraea teulerei* (Cazenavette, 1846) off the coast of south Oman, are mainly found in muddy salt marsh environments at low tide inside dead bivalves, such as *Cardidae*, *Glycimeridae* and *Pinidae* (Scali, 2013).

In the Atlantic, the author was able to observe this behavior as well; mating and spawning takes place in the summer, when the temperature of the water easily increases to 20°C. However, female cowries with eggs have also been observed in early October. The dead shells where the cowries laid their eggs are the most common bivalves found on the sea floor, including *Cardiidae*, *Ostreidae*, *Pectinidae* and *Veneridae*.

This information has been confirmed indirectly by others in Portuguese populations and may be the case in the Mediterranean as well, probably because the temperature of the water in these months is generally higher than in the Atlantic.

Figure 1 shows a female *Z. pyrum* var. *nigromarginata* perched upside down, with her foot extended to the inner surface of a piece of metal and covering a compact mass of eggs. This mass is a dense, deep yellow, half hemispherical in shape and rather stratified structure. The egg capsules are ovoid in shape (2 to 3 mm in length) and packed in clusters with each capsule containing between 32 to 34 eggs. The average number of eggs in a given clutch for this species has not been determined. Nonetheless, some authors suggest that the number in other cowries of planktonic development, like the genus *Zonaria*, are between 300 to 600 egg capsules. The complete development of the spawn take no less than five days and the color of the embryos inside the eggs may change substantially from the earlier stages to the last moment just before releasing and dispersal of the larvae. In addition, it is



Figure 3. *Zonaria pyrum insularum* var. *nigromarginata*. Female with eggs. The spawn is completely covered by her foot. Alboran Sea. Spain. 2008.



Figure 4. *Zonaria pyrum insularum* var. *nigromarginata*. Female specimen with eggs. The spawn, densely packed, yellow and somewhat stratified and consisting in clusters joined together by a gelatinous secretion is perfectly visible in the picture. Each cluster contains approximately thirty eggs where embryos develop inside before releasing to the environment. Alboran Sea. 2008.

important to note that the type of larval development (planktonic or direct development) provides valuable information about the natural history and evolution of these mollusks. Planktonic development takes approximately 5 to 30 days following dispersal and drifting with the current in the veliger stage before settling on the bottom in a suitable substrate. This is consistent with the author's observations in the Atlantic. Even though, advanced bulla stage cowries are hard to detect because of their smaller size (less than 10mm) and ability to hide in deep interstices, finding empty bulla and subadult shells are relatively common, especially after storms. For further information about this amazing chapter in the life of cowries, we suggest "Cowries: A Guide to the Gastropod Family Cypraeidae" by F. Lorenz, 2017 Chapter C, titled "Reproduction and Development", pages 58–68.

ACKNOWLEDGMENTS

Sincere thanks are given to the underwater photographer Antonio Rodríguez-Medel from Málaga (Andalusia, Spain) for allowing the author to publish his photographs and for the information provided through his official website <http://www.calahondabajoelmar.com> and to my friend Francisco Esteban Ortega from Granada (Andalusia, Spain) for additional information he provided on this beautiful cowry. A special thanks is given to my friend José Manuel Currás Santiago, from Marín (Galicia, Spain) for photographs of living shells from the Atlantic coast. Finally, many thanks to David B. Waller from Encinitas (California, USA) and David P. Berschauer from Laguna Hills (California, USA) Co-editors of "The Festivus" a publication of the San Diego Shell Club for their interest in the publication of this article.

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Waller, SDSC Acquisition Chairperson, at dwaller@dbwipmg.com to schedule a time to discuss charitable gifting.

CLUB NEWS

2018 May General Meeting

Our May meeting was held on May 19, 2018 at Leo Kempczenski's home in Tustin. There was food, beverages, and Leo Kempczenski gave a fascinating "slide" presentation on underwater diving and shelling in Guam.

2018 June General Meeting

Our June meeting was held on June 16, 2018, at David Berschauer's home in Laguna Hills. There was food, beverages, and David Berschauer gave a presentation on shells of the Californian Marine Molluscan Province, including digital images from the new book by D. Berschauer and R. Clark.

2018 July Shell Bazaar

Our popular annual shell bazaar was held on July 14, 2018 at Todd and Jill Spofford's home in San Diego. We had a great turnout with approximately twenty Club members in attendance. There was food, beverages, and lots of shells to share, trade and sell. A good time was had by all.

A History of People, Slugs and Type Localities at Bahía de los Ángeles, Gulf of California: Some Recollections

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Since the visit of John Steinbeck and Ed Ricketts in March 1940, the islands and region of Bahía de los Ángeles (BLA) have been known as an intriguing area of marine biodiversity. During an afternoon and a night of collecting at Puerto Refugio, on the northern point of Isla Ángel de la Guarda, Steinbeck and Ricketts, in fact, found four interesting species of heterobranchs: *Aplysia californica* Cooper, 1863, *Melibe leonina* (Gould, 1852), *Aegires albopunctatus* MacFarland, 1905, and *Berthellina ilisima* (Marcus & Marcus, 1967). Although the future winner of the Nobel Prize for literature and the now-legendary Monterey Bay marine biologist misidentified this last species as the European *Berthella plumula* (Montagu, 1803), it has long since been known to be a distinct eastern Pacific species which occurs throughout the Gulf of California to Ecuador, with El Niño-associated reports from southern California. All four of these species have varying affinities to the Oregonian, Californian, Cortezian, and Panamic Provinces. In their later-published classic *The Sea of Cortez* (1941), the two authors described their collecting at Puerto Refugio as follows: “This was a strange collecting place. The water was quite cold, and many of members of both the northern and the southern fauna occurred here” (Steinbeck & Ricketts, 1941: 227). Their remarks actually hold true for the entire Gulf of California region. Of the 165 species of Heterobranchia (including “Lower” Heterobranchia) reported by Bertsch (2010: 228), 91 species (55.2%) occur northward along the Pacific coast of California, 131 species (79.4%) occur southward in the Mexican and/or Panamic regions, and 65 species (39.4%) occur both to the north and south of the Gulf. Counting just the Nudipleura, the percentages are similar. Of the 122 species, 68 (55.7%) occur northward, 97 (79.5%) occur southward, and 48 (39.3%) occur both northward and southward.

It is little wonder that so many shell aficionados and underwater photographers, members of the San Diego Shell Club, and professional malacologists have visited or published on this area, including, James H. McLean, Eugene V. Coan, Dave and Margaret Mulliner (Mulliner, 1972), Carol and Paul Skoglund (Skoglund, 1988), Roy and Forrest Poorman (Poorman & Poorman, 1978), Larry Buck (Buck, 1992), Michael D. Miller (Bertsch, Miller & Grant, 1998), Kevin Lee, Antonio J. Ferreira (Ferreira, 1983), Doug Eernisse—the list goes on! James McLean published the first checklist of molluscs from BLA (McLean, 1961). He reported 405 species, primarily based on collecting records by Faye B. Howard and himself. Although there were no nudibranchs in the list, he did include a number of shelled “Lower Heterobranchia” and Cephalaspidea.

The map shows the study area in Baja California, Mexico. It includes the Gulf of California (Golfo de California) to the north and east. Key geographical features labeled include Isla Ángel de la Guarda, Canal de Ballenas, Isla Rasa, Archipelago de San Lorenzo, and Canal de San Felipe. The map also shows the coastline of Baja California. A north arrow is located in the upper left corner, and a scale bar in kilometers is at the bottom left. The map is overlaid with a grid of latitude and longitude lines.

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An interesting comparison can be made with two other northeastern Pacific sites that have an abundance of nudibranch type localities. The Monterey Peninsula is the type locality for 31 species of currently-valid nudibranch species, all named by Frank Mace MacFarland (one jointly with Charles H. O'Donoghue). He named them in six publications, spanning 60 years: MacFarland, 1905 (13 species), MacFarland in Cockerell & Eliot, 1905 (1 sp. and the genus *Dirona*), MacFarland, 1912 (1 sp.), MacFarland, 1923 (1 sp.), MacFarland & O'Donoghue, 1929 (1 sp.), and the posthumous MacFarland, 1966 (14 sp.). A handful of species he described in this latter work had been described in the years after his death, e.g., *Corambe bolini* = *Corambe steinbergae* (Lance, 1962), or are recognized as synonyms of earlier named species, e.g., *Petelodoris spongicola* = *Atagema alba* (O'Donoghue, 1927) (see Roller, 1970, and Bertsch &

Gosliner, 1986). Five of the species he named from the Monterey Peninsula have been reported from BLA: *Aegires albopunctatus* (first reported by Steinbeck & Ricketts, 1941), *Rostanga pulchra*, *Dendronotus* cf. *venustus*, *Hancockia californica*, and *Dirona picta* (see Bertsch, 2014).



Figure 3. Vista of northern part of bay, showing Punta la Gringa (center, small hill), Isla Coronado, and Isla Ángel de la Guarda (far background), November 2015. (Photo by Hans Bertsch, hereafter cited as HB)



Figure 4. Punta la Gringa, dive entry site, view to northeast, March 2017. (Photo by HB)

In contrast to the Monterey Peninsula, Puerto Peñasco, Sonora (at the extreme northern end of the Gulf of California) is the type locality for 12 species of Nudipleura, all described in one publication by Eveline and Ernst Marcus (Marcus & Marcus, 1967). Notable are three of these Gulf of California and Panamic species which have not yet been recorded from BLA. The rare *Cadlina luarna* has been reported from La Paz, Costa Rica, and Panamá. *Doriopsilla rowena* has been reported from further south to Panamá and the Galápagos, and in the Californian Province from La Jolla, California, to El Campo, near Punta Eugenia, Baja California Sur. In the past its identification has been confused with *Dendrodoris nigromaculata* (Cockerell in Cockerell & Eliot, 1905) (see Goddard & Valdés, 2015). *Chromolaichma sedna* (originally named as *Casella sedna*) “is the most common nudibranch at Puerto Peñasco. It is present throughout the year, but may be locally abundant during August” (from field notes by University of Arizona professor, Dr. Peter E. Pickens, who collected all the specimens described by the Marcuses, in Marcus & Marcus, 1967: 178). I have found this species at Las Arenas, Baja California Sur (common in June 1985), and Hermosillo (2006) reported it as the fifth most abundant species at Bahía de Banderas, Jalisco/Nayarit. But in more than 30 years of research, I have never seen this common far northern and southern Gulf species at BLA.



Figure 5. Punta la Gringa, dive entry site, view to southeast, May 2013. (Photo by HB)



Figure 6. Cuevitas, dive entry site, looking across the channel of Isla Coronado, February 2014. (Photo by HB)

What follows below is a list of the nudibranch species of BLA that have been named from 1964 to 2017. The list is in chronological order and includes brief histories about each of the species.

The Bahía de los Ángeles Nudibranchs

***Cerberilla pungoarena* Collier & Farmer, 1964**

Originally named from only one specimen collected at Puerto Refugio, Isla Ángel de la Guarda (29° 32' 50" N; 113° 55' 55" W) by John Sloan in March 1963. This sand-dwelling species is also known from various localities in southern California, including the Channel Islands. The name means “sand burrower,” from the Latin *pungere*, “to prick, puncture, penetrate,” in reference to its behavior described by Collier and Farmer: “This animal was collected crawling on top of sandy mud, and was later observed to have definite burrowing abilities. It completely submerged into the sand in an aquarium, the sand collapsing behind the animal as it passed through. As far as we can determine, this is the first recorded observance of an aeolid burrowing in sand. We did not determine what the animal eats in this peculiar habitat. The broad foot is particularly adapted for this kind of existence and the cerata are aligned for easy passage through the sand” (Collier & Farmer, 1964: 393).

***Okenia angelensis* Lance, 1966**

Jim Lance designated the type locality of this species as simply “Bahía de los Ángeles (lowest intertidal zone).” Its distribution overlaps temperate and tropical faunal provinces. It has been reported on the Pacific coast from San Francisco to Mission Bay, California, and in the Gulf; there is a possible record from Bahía de Coliumo, Chile (Schrödl, 1996). The specific epithet was chosen to honor BLA, “the geographic region where the species was first observed” (Lance, 1966: 76).

***Cuthona longi* Behrens, 1985a**

Named to honor Steven J. Long, this species’ type locality is Isla Rasa (28° 48' N; 113° 0' W), which lies about 8 km east of the boundary of La Reserva “BLA y Canales.” The original specimens were collected by Jeff Hamann in July 1982. No additional records of this colorful, 30 mm long aeolid exist. In the days before internet and Facebook connectivity, Steve published (1969-2009) the monthly *Opisthobranch Newsletter*, mailing it to colleagues worldwide. It included news and notes of what everyone was investigating, what they were doing and where they were visiting, along with short articles and lengthy bibliographic citations.

***Eubranchus cucullus* Behrens, 1985b**

Type locality, Puerto Refugio, based on specimens collected at 10 m depth by Jeff Hamann in August 1982. It has a wide distribution, from the BLA region south along the Mexican Pacific coast to Panamá. The Latin word *cucullus* means “hood” or “cowl,” in reference to the brown head coloration.

***Bajaeolis bertschi* Gosliner & Behrens, 1986**

Named for this author, *B. bertschi* is the first of nine species that have been named from the type locality of Punta la Gringa (29° 02' 34" N; 113° 32' 15" W). I remember the exact rock from which I collected the holotype, diving with Terry Gosliner. It is a wave-eroded pinnacle, sort of hourglass-shaped, with its upper surface exposed at low tide. The new monotypic genus *Bajaeolis* was named to honor the Baja California Peninsula.

***Polycerella glandulosa* Behrens & Gosliner, 1988**

This cryptic polycerid is named from the type locality of Punta la Gringa. It is known from Morro Bay to San Diego, California, and from BLA south along the Mexican Pacific coast and to Panamá. The name refers to the glandular swellings on its extra-branchial appendages.

***Trapania goslineri* Millen & Bertsch, 2000**

The type locality is Punta la Gringa, where honoree Terry Gosliner collected the holotype specimen on 29 June 1987. This species is known from Isla de Cedros, off the Pacific Coast of Baja California, and from BLA south to Bahía de Banderas, Jalisco/Nayarit.

***Peltodoris lancei* Millen in Millen & Bertsch, 2000**

The holotype specimen was collected and photographed by Michael D. Miller, 28 June 1996, at Punta la Gringa. The only other record of this species is from Isla Malpelo, Colombia (Kaiser & Bryce, 2001), more than 3000 km to the south, near the limit of the Panamic province. It is named for Jim Lance, “one of the first to know and love the opisthobranchs of the Gulf of California.” This species’ description was published in the Dr. Rudolf Stohler Memorial Issue of *The Veliger* (vol. 43, no. 4).

***Okenia angelica* Gosliner & Bertsch, 2004**

The type locality is Punta la Gringa. Also reported from Isla de Cedros, Baja California, Bahía San Carlos, Sonora, Bahía de Banderas, Jalisco, and Ixtapa, Guerrero (Hermosillo & Behrens, 2005). Although *O. angelica* is named for its “angelic appearance,” the species’ epithet also references the region and Jim Lance’s earlier *Okenia angelensis*.

***Dendrodoris stohleri* Millen & Bertsch, 2005**

The type locality is Punta Herradura (28° 56.51' N; 113° 28.89' W), on the eastern peninsula closing BLA. So far it is only known from BLA; note that it occurs far more commonly at the offshore “Islas” sites (pers. obser.) than at Cuevitas or Punta la Gringa. Named for Dr. Rudolf Stohler (1901-2000), founding editor of *The Veliger*. Although he never visited BLA, he was a mentor, colleague and friend to many of us who have (Bertsch, 2000).

***Diaulula nivosae* Valdés & Bertsch, 2010**

Known only from the holotype specimen collected at Punta la Gringa. “*Nivosa*” means “snowy,” appropriate because of the white frosting on the species’ dorsum, and my remembering a time snow was visible on the mountaintop east of town.

***Peltodoris rosae* Valdés & Bertsch, 2010**

Also only known from the holotype specimen collected at Punta la Gringa. Named in honor of Rosa del Carmen Campay Villalobos.

***Doriopsilla davebehrensi* Hoover, Lindsay, Goddard & Valdés, 2015**

Named for Dave Behrens, as a “replacement species” for the synonymized *Dendrodoris behrensi* Millen & Bertsch, 2005. Although the type locality was given only as “Bahía de los Ángeles, Baja California, Mexico, 12 June 2014” my collecting records indicate the specimen was actually collected at Cuevitas (29° 03' 45" N; 113° 32' 34" W), where Craig Hoover, Afelandra Cibrián, and I were scuba diving together. The morphology and coloration of this species have contributed to its misidentification at BLA and other sites in the Gulf of California as *Doriopsilla albopunctata* (Cooper, 1863). The paper by Hoover *et al.* (2015) differentiated this species from among a complex of pseudocryptic species. *Doriopsilla albopunctata* is known to range from Mendocino, California to Faro Viejo, Laguna Guerrero Negro, Baja California and *D. davebehrensi* is reported on the Pacific Coast from Newport Beach, California, and Punta Rosarito, Baja California and in the Gulf from BLA and Bahía de La Paz, Baja California Sur. The distribution of these two species in California is uncertain because of confusion arising from their similar appearances. During my 30-year study at BLA (1984-2014), it was the third most commonly found Nudipleura, after *D. bertschi* and *Berthellina ilisima*.

***Doriopsilla bertschi* Hoover, Lindsay, Goddard & Valdés, 2015**

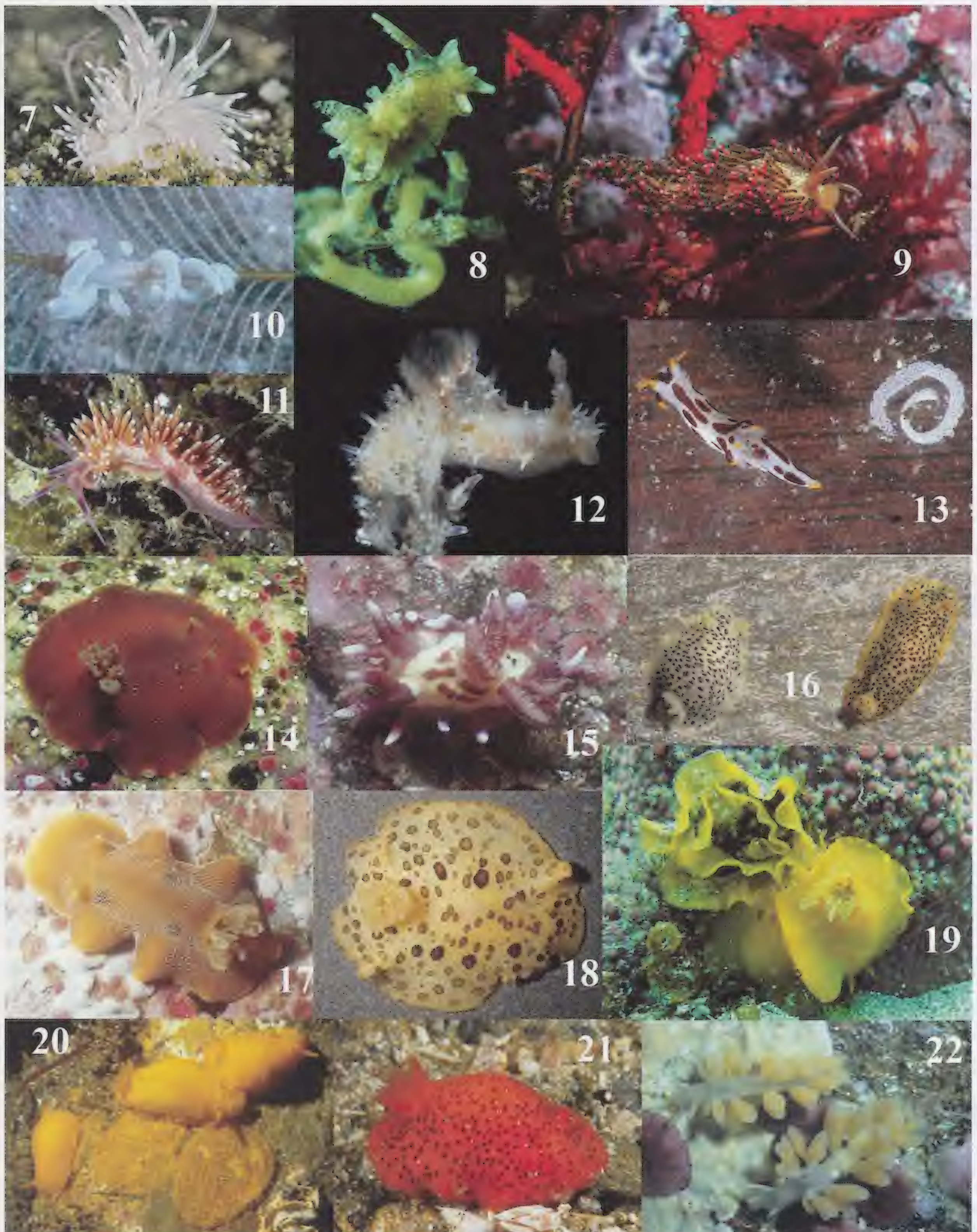
Type locality, “Bahía de los Ángeles, BC, Mexico, May 1960 (LACM 3421).” The original label specifies Isla Coronado, about 2 km east of Cuevitas and Punta la Gringa, as the collecting site, and hence type locality (pers. comm., Lindsey Groves). This Gulf endemic, currently known only from BLA, is distinguished from its Pacific coast congener *Doriopsilla gemela* Gosliner, Schafer & Millen, 1999, which has planktotrophic larval development (*D. bertschi* has direct development), as well as by its geographic occurrence and morphology. I greatly appreciated the species being named in my honor. It is the most common nudibranch I’ve observed during my decades of research at BLA. Sometimes a dozen or more animals can be found on massive yellow *Cliona californiana* at Cuevitas.

***Rostanga ghiselini* Gosliner & Bertsch, 2017**

The type locality is Punta la Gringa. It is currently known from three sites within the Gulf of California (Bahía San Luis Gonzaga, BLA and Guaymas) and from the intertidal area of Bahía Tortugas, Pacific coast, Baja California Sur (Angulo Campillo, 2000). Named for Michael T. Ghiselin.

***Tenellia ivetteae* Gosliner & Bertsch, 2017**

Type locality, Punta la Gringa. This little yellow-white aeolid is also known from Bahía de Banderas. Named in honor of Adriana Ivette Cadena.



- Figure 7.** *Cerberilla pungoarena*, holotype, Puerto Refugio, March, 1963. (From Collier & Farmer, 1964).
- Figure 8.** *Okenia angelensis*. (Photo by Jeff Hamann)
- Figure 9.** *Cuthona longi*, holotype, Isla Rasa, July 1982. (Photo by Jeff Hamann)
- Figure 10.** *Eubranchius cucullus*, Cuevitas, 20 December 1994. (Photo by HB)
- Figure 11.** *Bajaeolis bertschi*, Punta la Gringa, 24 September 1997. (Photo by HB)
- Figure 12.** *Polycerella glandulosa*, Cuevitas, 4 September 2015. (Photo by Craig Hoover)
- Figure 13.** *Trapania goslineri* and egg mass, in aquarium, Bahía Tortugas, Baja California Sur, 6 October 1998. (Photo by HB)
- Figure 14.** *Peltodoris lancei*, holotype, Punta la Gringa, 28 June 1996. (Photo by Michael D. Miller)
- Figure 15.** *Okenia angelica*, Punta la Gringa, 26 September 1997. (Photo by HB)
- Figure 16.** *Dendrodoris stohleri*, Punta la Gringa, 27 April 1986. (Photo by HB)
- Figure 17.** *Diaulula nivosa*, holotype, Punta la Gringa, 23 July 1995. (Photo by HB)
- Figure 18.** *Peltodoris rosae*, holotype, Punta la Gringa, 14 June 1996. (Photo by HB)
- Figure 19.** *Doriopsilla davebehrensi*, holotype, and egg mass on pink *Cliona californiana* prey sponge, Cuevitas, 12 June 2014. (Photo by HB)
- Figure 20.** *Doriopsilla bertschi* and egg masses on rock, Cuevitas, 4 May 2010. (Photo by HB)
- Figure 21.** *Rostanga ghiselini*, holotype, Punta la Gringa, 25 March 2017. (Photo by Craig Hoover)
- Figure 22.** *Tenellia ivetteae*, holotype, Punta la Gringa, 20 June 1992. (Photo by HB)

Namers, Namees and Other Folks: A Few Vignettes

The Festivus has, over the years, published many personal accounts of field trips to exotic locales. It therefore seems only fitting to publish herein not only a discussion of nudibranchs named from BLA, but also to include some personal vignettes about collecting trips to that area, and telling tales about both namers and namees. What follows are some reminiscences of some of the people with whom I have collected at BLA over the course of my almost 50 years of visiting there. Among the namees and namers, only three have never been to BLA: Dr. Rudolf Stohler, Steven J. Long, and Tabitha Lindsay (student of Ángel Valdés).

It Began with Clams

My first trip to BLA was in August 1971, accompanied by the bivalve expert Gene Coan. The pilot of our single-propeller craft was my friend Ray Holiday, who was a professional pilot for the now-defunct PSA (Pacific Southwest Airlines). We landed on the dirt airstrip and taxied over to Papa Diaz's (almost the only place in "town"), where we tied down to the tires buried in the hard-packed dirt for that purpose. Gene had recently published (Coan, 1968) a checklist for benthic molluscs dredged from BLA based on several expeditions sponsored by the Beaudette Foundation (Barnard & Grady, 1968). His report added 110 deep-water species (to 49 m depth) to James H. McLean's list. With Gene's passion for bivalves, we spent an hour or so exploring the shed where live-collected scallops were being processed for shipment to the United States. We watched the local workers quickly shuck the adductor muscle from each scallop and examined the piles of empty shells for other molluscs and epibionts (photos, Bertsch & Aguilar Rosas, 2016: 160). The divers were working beds of *Euvola vogdesi* (Arnold, 1906) at the southern end of Isla Ángel de la Guarda. It was a full-on over-harvesting, and it only took about two years (1971-1973) for the divers to wipe out the resource (Bowen, Danemann & Espinoza, 2014).

James R. Lance

Some 10 years later I again flew into BLA, this time with the nudibrancher Jim Lance. Jim worked for years as a laboratory technician at Scripps Institution of Oceanography, under the direction of Dr. William Fenical, studying marine natural products chemistry and marine pharmacology. He spent numerous vacations looking for nudibranchs in Puerto Vallarta, Nayarit (Miller, 2006), and regularly sampling (from 1953-2001) the intertidal pools along the rocky shores of La Jolla (Goddard *et al.*, 2013). In early May 1981, we joined Jeff Hamann and his father (our pilot) for an expedition to BLA. What I most remember about this trip wasn't the collecting, but our landing! As we bounced onto the dirt runway at BLA, the hydraulics on the front wheel broke and the left tire blew out. Our propeller (no longer elevated) was slightly chewed up by whirling into the dirt. We used rounded boulders to try to beat out the dings on the propeller, improvised a jack to repair the tire, and then wrapped fire hose with baling wire around the front wheel support shaft to keep its proper length, and hence the plane's nose up. The return flight involved two take-offs and three landings, each of which could diminish the distance between the propeller and the ground, which would not have been good (Bertsch, 2006). It is no secret that we did actually make it back to Gillespie Field in El Cajon, but our flight gave new meaning to the phrase, "on a wing and a prayer." Besides plane repairs, we did science while at BLA, collecting one morning on the low spring tides at Islas Gemelos. My field notes record over a dozen species, including *Aegires albopunctatus*, *Berthellina ilisima*, a "dark brown porostome" (*Doriopsilla davebehrensi*, unnamed at the time), and "yellow black porostomes" (*Dendrodoris stohleri*, also unnamed then).

Wesley M. Farmer and Clinton L. Collier

Wes Farmer, (U. S. Army veteran, having served as a medical technician at Fort Ord, CA, Ft. Chaffee, AK, and Ft. Bliss, TX) and I visited BLA in July 2008. I was selling my Chevy pick-up to Ricardo Arce, who owns the dive shop there, and I needed an extra driver for the drop off. Things had certainly changed since he and Clinton L. Collier had made their trips along the coasts of Baja California to observe and collect the opisthobranch fauna of the region in the early 1960s! While I scuba dove at Punta la Gringa and Cuevitas, Wes set up his easel, and whiled away the time painting the vistas. Like Wes, Clint is a veteran, serving six years in the U.S. Air Force as a missile launch operator, and later moving on to computer information systems and consulting for the rest of his career.

David W. Behrens

Dave Behrens visited BLA back in the early 1970s. The transpeninsular highway had just been completed in 1973, so he and a group of Pacific Gas & Electric biologists caravanned south from the Morro Bay, California area, camping out on the spit at La Gringa and even diving at Isla Coronado. He recently wrote me, "I'll bet I saw *D. davebehrensi*, and didn't realize what I was seeing." Of course at that time, *Doriopsilla davebehrensi* hadn't been reported in the Gulf, not even as "*D. albopunctata*" (see Behrens, 1980).

Michael T. Ghiselin

Michael Ghiselin, Darwin scholar and evolutionary biologist (Ghiselin, 1969, Cimino & Ghiselin, 2009, *etc.*), and recipient of the MacArthur Prize Fellow “genius award,” is currently Senior Research Fellow at California Academy of Sciences (CAS). Although he nicknamed himself “Captain Armchair” when I was his Ph.D. student at the University of California, Berkeley, we have shared many expeditions along the shores of the Baja California peninsula. In September 1982, he completed his open water scuba training dives at BLA; as a PADI instructor, I certified him as a scuba diver. On that trip (you can’t train a marine biologist underwater to not look for organisms!) we even found the then-unnamed *Trivettea papalotla* (Bertsch, Valdés & Gosliner, 2009), with egg masses, on its epizoanthid prey. In 1984, with funding from the George Lindsay Field Research Fund, we participated in two international reconnaissance expeditions (Bertsch, 1985) with staff, faculty, and students from CAS, Ciencias Marinas (Universidad Autónoma de Baja California), and CICESE (Centro de Investigación Científica y de Educación Superior de Ensenada). We drove over paved and dirt roads, and across mirage-filled sand flats, stopping to dive at sites in Baja California Sur, from Bahía Tortugas, Loreto, Isla Magdalena, and Las Cruces to the sand falls in the canyon at Cabo San Lucas. We found over 30 species of slugs, including the expected tropical or temperate species such as *Felimida norrisi* (Farmer, 1963), *Flabellina iodinea* (Cooper, 1863), and *Conualevia alba* Collier & Farmer, 1964. There were also the unexpected new species or range extensions (*e.g.*, Gosliner & Bertsch, 1985). All this, despite over five flat tires, a busted body frame on one vehicle (requiring welding), and a blown radiator. But every morning’s campsite was awakened by Mike handing each of us a hot cup of coffee, while we were still in our sleeping bags.

Terrence M. Gosliner

Terry Gosliner and I have meandered together for decades, since the early days in the 70s. Our first expeditions, with Gary Williams and their brothers Michael and Scott, were a bit primitive, camping, snorkeling and working the intertidal in Puerto San Carlos, Sonora, and Puertecitos, Baja California (Williams & Gosliner, 1973). We’ve collaborated on species descriptions from Hawaii and Baja California, his dissecting and analytical skills being paramount. Terry has crisscrossed the Pacific from Hawaii (studying with E. Alison Kay) to South Africa (Gosliner, 1987). Since moving to the California Academy of Sciences, he has been exploring the incredibly rich diversity of slugs in the Coral Triangle (Gosliner, Valdés & Behrens, 2015), and helped pioneer DNA studies in elucidating their evolutionary history and relationships. We have been to BLA various times, with various colleagues. Most memorable was our trip in October 1984 with Antonio Ferreira and members of the CAS staff (including Bob Van Syoc). We dove at Punta la Gringa, Puerto Don Juan, and on the sunken boat wreck between Islas Ventana and Cabeza de Caballo. Collecting was great, as we found specimens of six species that would only be named in the coming decades, including *Bajaeolis bertschi*, *Trapania goslineri*, and *Doriopsilla davebehrensi*. Our shadeless campsite at La Gringa was raw, and it was hot. In addition to drinking water and food, we had a bucket of fresh water for washing—but only for regulators and camera. It was a salty-faced week.

Sandra V. Millen

Sandra Millen and her husband Sven Donaldson joined us on other expeditions. One morning we were eating breakfast on our hotel patio, and a fellow walked up to us saying his van was stuck in the sand north of town. “Oh, ok, after breakfast.” But when he said his wife and children had been left out there, we quickly rolled into action with my Jeep and a tow rope for the rescue. Sandra found that the waters of BLA were much warmer than at her local Canadian dive sites.

Ángel Valdés

Ángel Valdés is the other professor whom I certified as a scuba diver. In March 2000, we did his certification dives in the La Paz area and then drove back up to BLA, where we were joined by Mike Miller and Alan Grant. Ángel told me he wanted to take some live specimens of the Gulf “*Doriopsilla gemela*” back to California Academy of Sciences, so I took him out to Cuevitas where I knew they were abundant and which for years I had called “the yellow-gilled porostome.” Sure enough, we found over 30 individuals. It would be another 15 years before DNA technology determined it was the pseudo-cryptic species, *D. bertschi*. After a few days, Alan and Mike left several hours ahead of us, to return to points north of the border. When Ángel and I departed, we found them stopped alongside the road, some 20 miles west of town, with a flat tire. While two Ph.D.s and a Doctor of Dentistry looked on, Mike replaced the tire!

Craig Hoover

Craig Hoover (another of Ángel’s Master’s degree students at California State Polytechnic University, Pomona) and I have made a half-dozen trips along both coasts of the BC peninsula. We have taken boats out to Isla Magdalena under high seas and huge swells, only to encounter totally flat seas a day later at BLA. We have endured over 100° F desert temperatures in La Paz, rock slides covering the Transpeninsular Highway south of Loreto, pummeling and flooding from the winds and rains of Hurricane Marie, and days without lunch that ended with feasts of carne asada. Our coldest water temperature was 56° F at BLA in March 2017. On our dives at La Paz, Bahía Magdalena, Faro Viejo (Laguna Guerrero Negro) and BLA, Craig and I have recorded range extensions and found known and previously unknown, undescribed species. One evening in our hotel room at BLA, we were examining the external morphology and coloration of a 6 mm unique specimen of a new *Tritonia*, which he had found that afternoon at La Gringa hidden cryptically on its prey *Leptogorgia alba*. While we were transferring this small white animal from the petri dish of the compound microscope to a large dish for portrait photography, it fell on the floor. WHOOPS! Frantically, Craig and I got on our hands and knees, searching for our possible holotype on the white tile floor of our hotel room. We found it. It is now undergoing DNA analysis and dissection. The type locality will not be Room 5 at Hotel Costa del Sol.

Jeffrey H. R. Goddard and Rosa del Carmen Campay Villalobos

Namer and field biologist Jeff Goddard has rolled rocks in intertidal zones at BLA and on the Pacific coast of the peninsula with his wife Lise and sons Ziggy and Will. Eight years ago, along with Rosa del Carmen Campay (grandmother of Ivette Cadena) and Brenna and Brian Green, we worked the intertidal rocks in front of the BLA beachfront home of Antonio and Bety Reséndiz. We found *Felimida norrisi* and the “yellow-gilled porostome,” among other slugs. Then we

crossed the peninsula for the next day's low tide at El Tomatal. While Jeff and his family camped on the beach, Rosa, Brian, Brenna, and I celebrated New Year's at the Hotel Pinta in Guerrero Negro with genuine Mexican-brewed toasts.

Adriana Ivette Cadena

The last namee to mention: my granddaughter Ivette. Her first visit to BLA was in August 2005, actually a month before she was born! Her mom spent hours floating on the warm waters of the bay, relieving the gravity stress of her pregnancy. Ivette's first word was not *nudibranquio*, but it was close. We have seen the whale sharks together, and she has given me great assistance on the beach as the "safety officer" while I was diving solo at Punta la Gringa. She currently lives in Chiapas with her family and is the only person in all of México who has both a genus (*Trivettea* Bertsch, 2014) and a species (*Tenellia ivetteae*) of nudibranch named in her honor.

Why We Do Science

Science is really for the children. Naming *Tenellia ivetteae*, Terry and I wrote, "This species is named in honor of Señorita Adriana Ivette Cadena, granddaughter of Hans, who has helped with his research at Bahía de los Ángeles. She and her brothers and sisters--the children all around the world--remind us why we must do science and do it well: to present informed knowledge for informed decisions affecting their future and the life of our planet" (Gosliner & Bertsch, 2017: 126).

During their expedition throughout the Gulf, Steinbeck and Ricketts were asked by children watching them in the intertidal zone, "Why do you do this thing, this picking up and pickling of little animals?" The two men pondered the usual responses: we do science to discover, to advance knowledge, or to help mankind. But they eventually came to an insightful realization:

"Finally, we learned to know why we did these things. The animals were very beautiful. Here was life from which we borrowed life and excitement. In other words, we did these things because it was pleasant to do them....Here was no service to science, no naming of unknown animals, but rather--we simply liked it." (Steinbeck & Ricketts, 1941: 209, 270)

It seems that is just what a child would say.

Bahía de los Ángeles is a special place for nudibranchs and a place for special people. Look carefully, protect life, and enjoy.

ACKNOWLEDGMENTS

I am deeply grateful for all the people mentioned in this article; without their friendship, collegial searches, patience and knowledge, this manuscript never could have been written. Over the years many other divers have accompanied me to BLA, especially Tom Smith, Brian Coleman, and Luis Aguilar. Robert Dees has earned a special thank you for his insightful and invaluable comments on the preliminary draft of these recollections.



Figure 23. Steve Long, Eveline Marcus, Hans Bertsch, and Jim Lance; La Jolla, California, 7 July 1984. (Photo from HB)

Figure 24. Dr. Rudolf Stohler; Pacific Grove, California, meeting of the Western Society of Malacologists, June 1969. (Photo by James H. McLean)

Figure 25. Tabitha Lindsay; intertidal zone, central California, March 2014. (Photo by Craig Hoover)

Figure 26. Gene Coan; scallop processing plant, BLA, 25 August 1971. (Photo by HB)

Figure 27. Jim Lance; wing-man helping repair flat tire, BLA, May 1981. (Photo by HB)

Figure 28. Clinton Collier, intertidal zone at Bahia San Luis Gonzaga, 29 November 1963. (Photo by Wes Farmer)

Figure 29. Wes Farmer; painting scenery at Cuevitas, 10 July 2008. (Photo by HB)

Figure 30. Dave Behrens; Morro Bay, California, 1974. (Photo courtesy Dave Behrens)

Figure 31. Mike Ghiselin and Hans Bertsch; writing field notes, BLA, 28 February 1989. (Photo by Tom Smith)

Figure 32. Hans Bertsch, Terry Gosliner, Robert van Syoc, and Antonio Ferreira; after-dive celebration, BLA, October 1984. (Photo from HB)

Figure 33. Mike Miller and Sandra Millen; BLA, February 1999. (Photo by HB)

Figure 34. Alan Grant, Mike Miller, and Ángel Valdés; repairing flat tire, on the road west of BLA, 17 March 2000. (Photo by HB)



Figure 35. Six BLA nudibranch workers: Terry Gosliner, Hans Bertsch, Mike Miller, Ángel Valdés, Jeff Hamann, and Dave Behrens; Seattle, Washington, meeting of the Western Society of Malacologists, 1 August 2006. (Photo from HB)

Figure 36. Craig Hoover underwater; photographing the holotype of *Doriopsilla davebehrensi*, *in situ*, on the pink prey sponge, with its egg mass, 12 June 2014. (Photo by HB)

Figure 37. Hans Bertsch underwater; photographed *in situ*, with *Doriopsilla bertschi* (on rock, at left, yellow) and *Doriopsilla davebehrensi* (on rock, at right, orange), Punta la Gringa, 25 November 2015. (Photo by Kevin Lee)

Figure 38. Jeff Goddard and sons Will and Ziggy; intertidal at BLA, 28 December 2009. (Photo by HB)

Figure 39. Rosa del Carmen Campay; with *Doriopsilla bertschi* on yellow sponge *Cliona*, 28 December 2009. (Photo by HB)

Figure 40. Ivette Cadena; testing dive equipment at Punta la Gringa, 28 December 2011. (Photo from HB)

Figure 41. Ivette Cadena; protecting diver, Punta la Gringa, 28 December 2011. (Photo from HB)

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Figure 42. Rainbow over the bay; BLA, 25 November 2015. (Photo by HB)

The Seychelles - Our Amazing Indian Ocean Adventure

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February 19, 2017 / Victoria, Mahé, Seychelles

My overwhelming desire to visit Seychelles became a reality on February 19, 2017. My husband and I boarded an Emirates plane from Dubai, U.A.E., to Victoria, Mahé, Seychelles in the Indian Ocean. After a 4+ hour flight, we arrived, went through Customs and were transported to the Eden Blu Hotel on Eden Island. We were escorted a short walking distance away to the Eden Island Marina and embarked the *Crystal Esprit*. The *Crystal Esprit* is a small luxury ship catering to adventure seeking travelers. She has 31 suites which equates to a maximum capacity of 62 guests. Unlike other cruise ships requiring large ports, the *Crystal Esprit* offers an incredible cruising experience with the capability of accessing hard to get to bays, coves and uninhabited islands. This advantage rewards her guests with the bonus of exclusivity allowing one to truly experience nature first hand, uncompromised and uninterrupted. A list of species that were self-collected and those that were purchased from a fisherman are listed at the end of the article.

First, a brief geological history lesson. The Seychelles are an exotic and remote archipelago located some 1,000 miles off the coast of Kenya, Africa. The Seychelles uniqueness began approximately 66 million years ago when a part of the granitic Mascarene Plateau broke off from the Indian Plate. Out of the 115 islands comprising the Seychelles Archipelago only 45 are granitic. They are referred to as the Inner Islands and consist of the major islands of Mahé, Praslin, LaDigue and Silhouette. This is the area we will be cruising. The remainder of the Seychelles islands in the archipelago are coralline in nature and are referred to as the Outer Islands. The Inner Island group of Seychelles is the world's only oceanic islands of granite rock.

February 20, 2017 / Moyenne Island off St. Anne Island

After breakfast, we travel to Moyenne Island off St. Anne Island. Our zodiac makes a beach landing and we are dropped off at what actually was a sand bar at low tide to swim and snorkel. We snorkeled for a short while but soon concentrated our shelling efforts on that temporary tiny strip of sand. We did find some nice shells in good condition interspersed amongst sea weed. There was an assortment of very nice gastropod and bivalve species with a few having washed up with both valves intact. After two hours we were picked up by zodiac and transported back to the *Crystal Esprit*. This afternoon we cruise to our second day destination. We prepare for a very tropical, humid walking tour and are warned to apply huge amounts of mosquito spray.

February 20, 2017 / Cousin Island Special Reserve

This tour offered an amazing opportunity for discovery, education and adventure. Cousin Island is uninhabited except for the few people who live there to protect the welfare of the island and care for animals when necessary. Also, they are invaluable guides who intimately know and understand the rhythm and needs of this special place.

Seychelles is big on birds and this is one of the best islands to see these beautiful creatures in a natural environment who have no fear of humans. Our guide explained the uniqueness of several. Fairy Terns don't make nests. They lay their eggs on "forked" tree branches and limbs of trees. We saw many White-tailed Tropicbirds and learned that they lay their eggs in nests on the ground against the bases of trees. Even though our group was within 1-2 feet of the parent, it remained still, quiet and obviously content. With the help of the guide we were able to see a juvenile bird underneath a nesting parent. A pretty white ball of fuzz and fluff. We observed the endemic Seychelles Magpie, and saw wild lavender orchids along with many large terrestrial hermit crabs flaunting some pretty nice gastropods on their backs. We witnessed a female Loggerhead Turtle making her way up the beach to dig a nest to lay her eggs. But, the most thrilling event of the afternoon was being greeted by one of the Aldabra Giant Tortoises. The most famous and friendly is a very old fellow named "George". He is social, inquisitive and enjoys interacting with people. He followed us around like a dog for a short time on the beach. I sat down on a cinder block to pet his head and he "came in for a closer look" nearly knocking me off of my perch. I was wearing a bright multi-colored green top that day and my husband said he must have thought I was a big salad. "George" always seemed to have a smile on his face which makes him the most wonderful animal ambassador I have ever met.



Figure 1. A nesting White-tailed Tropic Bird. Cousin Island Special Reserve, Seychelles, 2-20-2017.



Figure 2. A Fairy Tern on egg(s). Cousin Island Special Reserve, Seychelles, 2-20-2017.

February 21, 2017 / Anse Lazio Beach, Praslin Island

Mid-morning, we take a tender ride to a pier on Praslin and are lucky to see a Green-backed Heron. It was taking advantage of a fish feeding opportunity being offered by a visitor throwing potato chips in the water. We boarded our tour bus traveling over the mountainous interior and arrive at Anse Lazio Beach. Unfortunately, today is not a good snorkeling day. It is overcast and the waves are rough and crashing over the smooth orange colored granite boulders dotting the shoreline. After successfully beachcombing for shells, we wander toward those granite pinnacles in hopes of finding something pretty. We weren't disappointed. Right before our eyes clinging to the rock surface, we found nerites, monodonts, periwinkles, limpets

and chitons. We were also surprised to see Skipper Fish jumping from rock to rock as we approached them. A first for us. I also found a nice collection of sea glass treasure. Our time passed by very quickly. After nearly four hours of sheer bliss, including taking some time out to lay underneath a palm tree, we boarded our bus back to the pier and transferred to the *Crystal Esprit*.

February 22, 2017 Coco Island and Félicité Island, off LaPasse, LaDigue

This afternoon we board a private tour boat which will take us snorkeling off Coco Island and Félicité Island. Again, the water is rough. We jump in and slowly snorkel to Coco Island. It is sad to say how much broken dead coral littered the bottom here. Every now and then we saw a few extremely small healthy colorful corals but, they were few and far between. The water was filled with beautiful tropical fish species such as Powderblue Surgeonfish, Convict Tangs, Parrotfish and the extravagant Picassofish to name a few. The Needle-spine Urchins had colonized the bottom. I saw a Trumpetfish for the first time. The tiny island is very picturesque with a beautiful assortment of granitic monoliths and palms. We did collect Serpent's-head Cowries with worn lavender dorsums. Most shells were pretty banged up. After a while, we snorkeled back to the boat which took us to Félicité Island. Here, again, we are greeted by a very tiny beach, rough waves and slim pickings. I did find a few shells, sea glass and some very small attractive pieces of dead coral. This makes us more determined for better results tomorrow.



Figure 3. Granitic boulders. Coco Island, off LaPasse, LaDigue, Seychelles, 2-22-2017.

February 23, 2017 / Laraie Bay, Curieuse Island

The weather has greatly improved and we have sunny skies and calm water. Once again, the zodiac maneuvers a successful beach landing right onto Laraie Beach. This is an amazingly beautiful destination. Once on shore, we don our snorkeling gear and immerse ourselves in tranquil blue water. We find Lollyfish and Greenfish hiding in sea grass. Very peculiar creatures. We see many of the fish species we did the day before and add the Scissortail Sergeant Fish to the list along with squirmy Red Needle-spine Brittlestars under rocks. As a person concerned with water quality, I am happy to say that this location has a huge diversification of healthy sea grasses. In most places, much of the bottom was so heavily covered it looked like an underwater forest. There were myriad shades of green. The most stunning was a spectacular bright emerald green. Healthy sea grasses serve as safe havens for sea life and also as nurseries for young providing hiding places from possible predators. I found several cone and cowrie species amongst scattered rocks and coral in less than 6 feet of water. However, the most wonderful surprise of the day was the four Giant Spider Conchs we discovered in less than 10 feet of water. We admired and played with the most beautiful one bringing it up to the surface for photographs.

I had no idea this species could possess such a rich and vibrant color palette consisting of burgundy and gold. This was the first live specimen I had ever seen. The Giant Spider Conch shell will lose its beautiful colors very quickly within a matter of days once taken. This explains why the specimens you see on dealer's tables at shows are pale and off-white in color. After enjoying our spectacular find, we returned it to its watery home.

After a few hours in the water, I walked a small portion of that gorgeous beach with those tall, smooth granite boulders at the shoreline. It is here that I left some of my mother's ashes. She traveled extensively during her lifetime and would be very happy knowing she still continues to fly jets around the world visiting some of the loveliest places on Earth.



Figure 4. Giant Spider Conch found in less than 10 feet of water while snorkeling. Laraie Bay, Curieuse Island, Seychelles. 2-23-2017.

Back onboard, the thrills continue as we have two tickets to board the *Genting Explorer*, *Crystal Esprit's* underwater submersible. She is truly a sight to behold painted a shiny bright red. She carries two guests and a captain. It was such a thrill to be inside that large glass bubble looking out at the seascape underneath the waves. I have never seen such large schools of fish as I did that afternoon. A symphony of synchronized swimmers suddenly moving from one direction to

another like characters in a well-rehearsed choreographed underwater ballet. We also had a very close encounter with a curious Star Pufferfish which swam right in front of the glass taking a closer look at us. Just as soon as we got relaxed staring out at the view, our 20 minutes were up – and so were we - breaking topside. A truly exciting and memorable day to say the least.



Figure 5. The *Genting Explorer* back on board *Crystal Esprit*. Off Curieuse Island, Seychelles. 2-23-2017.

February 24, 2017 / Aride Island National Park

This morning we are swiftly transported by zodiac to the shore of Aride Island. As with Cousin Island, Aride is protected and overseen by a few souls who live there to protect this natural resource and treasure. We met our knowledgeable guide who will take us hiking up a mountain. While on our way we see some fascinating creatures, some of which are endemic to Seychelles. We find the Seychelles Land Crab, Wright's Skink, Brown Noddy Bird. The guide also pointed out a beautiful tree in full bloom. The flowers of this tree reminded me of the flower of the Mimosa tree. The flower is fragrant, with numerous showy soft, long, white needle-like spikes with pink colored tips. But, this is where the similarities quickly end. He tells us that the name of the tree is the "Fish Poison Tree" and it comes from Asia. He says all parts of the tree are poisonous. The seeds are ground into a powder and used to stun or kill fish leaving the flesh of the fish unaffected. The seeds are capable of traveling ocean currents and can survive up to 15

years adrift. Amazing! Shortly after, we soon begin our ascent to the top. The uneven dirt trail is slick from rain the day before. Everyone carefully watches the placement of each footstep. A couple of guests are carrying heavy camera equipment with large zoom lenses. Their climb up was much more difficult as they only had one free hand to help them access a tree limb or a sturdy rock to help with balance. Along the way up our guide picks up a Giant Millipede for us to see and we encounter numerous damselflies and butterflies flitting about. There were many White-tail Tropic Birds sitting on nests. Eventually, everyone successfully maneuvered the climb and we were rewarded with a most stunning view. As we had accomplished our goal, we were happy in the knowledge of knowing that it is harder going up than it is going down. After our descent to level ground we were once again back on the beach. We find limpets and eroded lavender capped Serpent's-head Cowries. Not much in the way of shells, but the natural beauty of this pristine place made up for that. We board the zodiac back to the ship, have lunch and prepare for our afternoon adventure.



Figure 6. Terrestrial hermit crab. Aride Island National Park, Seychelles. 2-24-2017.

February 24, 2017 / Grand Soeur Island (Big Sister Island) Coco Anse, Coco Bay

Big Sister Island is a private island with a total population of 2 permanent inhabitants. We wish we knew them! The ocean side has a gorgeous beach, tall palms, large granite boulders and teal/turquoise blue water. It is considered to be one of the most beautiful beaches in the world and is seen in many travel photographic layouts depicting Seychelles. We concentrate our time snorkeling on the opposite side in Coco Bay. The day is perfect with sunny skies and light breezes. This is an incredible island to visit, with permission, which offers many exciting snorkeling opportunities. In addition to the tropical fish species already mentioned, we can add sightings of Batfish and Moorish Idols. Coral is prolific and seems to be thriving along with Needle-spine Urchins. We turn over many rocks looking for shells. Again, we find Red-Needle-spine Brittlestars as well as Serpent's-head Cowries which are plentiful. We also found Gold-ringer Cowries and Money Cowries, the latter in both smooth and knobby forms and a pretty Caurica Cowrie with a bluish tint. All of these shells were found in less than six feet of water under and between rocks and coral. All rocks were returned to the position in which initially found. Incredibly, to my complete amazement, while snorkeling in the surf at the shoreline, I found two Vermiculate Cones and three Hebrew Cones. All were clinging to a smooth granite bottom. If I had been walking the shoreline, I probably would have stepped on them. We came ashore and did some beachcombing. Didn't find much in the way of shells, however, we were rewarded with some very pretty coral fragments and sea glass before jumping into a zodiac which returned us to the *Crystal Esprit*. This was the last water day on the trip.

February 25, 2017 / Victoria, Mahé Island

This morning, our tour begins with a stop at the largest open-air market in Victoria named Sir Selwyn-Clarke Market. It is Saturday – the busiest shopping day of the week. We step inside and see an amazing variety and selection of fish, octopus, fruits, vegetables, spices, and, of course, souvenirs. I asked our tour guide if she knew of anyone who sold shells. She said “Yes, follow me.” I was introduced to a fisherman who had a large selection of cleaned shells for sale. I had twenty minutes and made quick work out of the assortment he placed in front of me. After I had chosen the thirty-two shells I wanted, he wrapped them for me, wrote up a paper receipt and quoted me the price he wanted which was in rupees. We converted the rupees into American dollars. The price was extremely modest. I paid him and then he picked out a few more shells he wanted me to have and gave them to me. He, I am sure, was happy I came that day and I was even happier!

Next, we travel up a steep mountain road to see the ruins of what was originally named “Venn's Town.” Today it is known as the “Mission.” It was a boarding school founded in 1875 by the Rev. William Chancellor to care for and educate children of freed slaves. There is a very commanding view from the top offering scenic views of the island and the Indian Ocean. It is here we see tea plants and smell the bark of cinnamon trees.

Our last stop is the Seychelles Botanical Gardens. It is one of the oldest national monuments in Seychelles dating back more than a century. It is filled with an assortment of established plantings set in natural landscapes with many specimens being endemic to Seychelles such as the Coco de Mer, whose seed is the largest in the plant world. On very tall trees we saw the



Figure 7. Purchasing seashells. Sir Selwyn-Clarke Market, Mahé, Seychelles. 2-25-2017.

Seychelles Fruit Bat hanging upside down. It was a perfect photo opportunity for the flower enthusiast with most plants being in bloom. It wasn't long before I spied a few visitors that are not welcome in such a lovely floral setting. The Giant African Snail, *Achatina immaculata*, were happily plying their way through ground foliage. Big Rascals! Soon, we entered an enclosure with several Aldabra Giant Tortoises. The staff handed us several long-stemmed leaves so we could feed them. I didn't know I was in for another surprise. I turned my head and saw a juvenile *A. immaculata* hitching a ride on the back of one of the tortoises. I quickly plucked it off and wrapped it in a paper towel. It resides in my collection accompanied by this very funny story. Soon, we meet up with our tour guide and return back to the *Crystal Esprit*.

The next day, we say good-bye and disembark the luxurious *Crystal Esprit*. We check into the Eden Blu Hotel on Eden Island for the day until our Emirates flight departs later that evening for Dubai, U.A.E. Our Seychelles Indian Ocean adventure was inspiring, rewarding and more than we had hoped for. A paradise found and a naturalist's dream come true.

SPECIES SELF-COLLECTED IN SEYCHELLES:

Anodontia edentula (Linnaeus, 1758)
Barbatia candida (Helbling, 1779)
Canarium mutabile (Swainson, 1821)
Cardita variegata Bruguière, 1792
Cellana radiata (Born, 1778)
Codakia tigerina (Linnaeus, 1758)
Conus (Pionoconus) catus Hwass in Bruguière, 1792
Conus (Virroconus) chaldaeus (Röding, 1798)
Conus (Virroconus) ebraeus Linnaeus, 1758
Diodora singaporensis (Reeve, 1850)
Divaricella chavani Cosel, 2006
Donax cuneatus Linnaeus, 1758
Drupa morum Röding, 1798
Drupa ricinus (Linnaeus, 1758)
Naria helvola (Linnaeus, 1758)
Erronea caurica dracaena (Born, 1778)
Gafrarium dispar (Holten, 1802)
Littoraria coccinea glabrata (Philippi, 1846)
Littoraria scabra (Linnaeus, 1758)
Vanikoro cancellata (Lamarck, 1822)
Monodonta australis (Lamarck, 1822)
Nerita polita (Linnerita) Linnaeus, 1758
Stomatia irisata (Dufo, 1840)

Monetaria annulus (Linnaeus, 1758)
Monetaria caputserpentis (Linnaeus, 1758)
Monetaria moneta (Linnaeus, 1758)
Modiolus auriculatus (Krauss, 1848)
Morula uva (Röding, 1758)
Nassarius arcularius plicatus (Röding, 1798)
Nassarius conoidalis (Deshayes, 1832)
Neocancilla clathrus (Gmelin, 1791)
Nerita (Theliostyla) albicilla Linnaeus, 1758
Nerita (Ritena) plicata Linnaeus, 1758
Palmadusta asellus (Linnaeus, 1758)
Phasianella solida (Born, 1778)
Phenacolepas asperulata (A. Adams, 1858)
Ranularia gallinago (Reeve, 1844)
Scissulina dispar (Conrad, 1837)
Siphonaria atra Quoy & Gaimard, 1833
Tonna caniliculata (Linnaeus, 1758)
Stomatella orbiculata A. Adams, 1850
Trochus maculatus Linnaeus, 1758
Vasticardium flavum (Linnaeus, 1758)
Scutellastra exusta (Reeve, 1854)
Terebralia palustris (Linnaeus, 1767)

SPECIES PURCHASED AT MARKET:

Atrina vexillum (Born, 1778)
Canarium erythrinum (Dillwyn, 1817)
Colubraria muricata (Lightfoot, 1786)
Conus (Dendroconus) betulinus Linnaeus, 1758
C. (Gastrium) obscurus Sowerby I, 1833
C. (Harmoniconus) musicus Hwass in Bruguière, 1792
C. (Pionoconus) striatus (Linnaeus, 1758)
C. (Virgiconus) virgo Linnaeus, 1758
Cypraea tigris Linnaeus, 1758
Filifusus filamentosus (Röding, 1798)
Harpago arthriticus (Röding, 1798)
Hemifusus ternatanus (Gmelin, 1791)

Lambis truncata ([Lightfoot], 1786)
Latirolagena smaragdulus (Linnaeus, 1758)
Mancinella tuberosa (Röding, 1798)
Mancinella alouina (Röding, 1798)
Mauritia histrio (Gmelin, 1791)
Mimachlamys sanguinea (Linnaeus, 1758)
Minnivola pyxidata (Born, 1778)
Phalium fimbria (Gmelin, 1791)
Pinctada margaritifera (Linnaeus, 1758)
Polinices mammilla (Linnaeus, 1758)
Turbo argyrostomus Linnaeus, 1758

The Club's San Diego County Fair Exhibit

Lisa Dawn Lindahl

212 S. Orange Avenue #213, Brea, CA 92812

lindahldesigns@gmail.com

The San Diego Shell Club was once again a welcome presence at the annual Del Mar Fair in San Diego, June 1st through July 5th, 2018.

Entitled "Gems From The Ocean", our 4th year exhibiting in the Gems and Minerals Hall, our Club's exhibit had the popular vote for some truly outstanding examples of a variety of shells from around the world. This was a great chance for the general public to catch the "shell bug" as well as an introduction to malacology's San Diego "shell ship."

Several hundred fair spectators stopped by and were treated to some short and sweet presentations by a couple of our "seasoned" shellers, a.k.a. docents. A special thanks to Lawrence Buck, Rick Negis, William Schramm and Paul Tuskes for their carpentry skills! Also a shout out to the folks who brought shells from home to show off. I was privileged to get to create the cube display for the second year; how can you go wrong with beautiful coral and some *Spondylus*! Cheers!



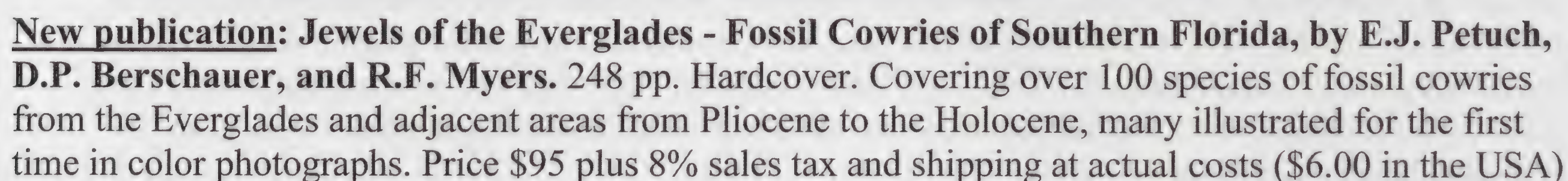
Figure 1. Lisa Dawn Lindahl with the cube display.



Figure 2. One of the long shelves of the Club's display.



New publication: *Seashells of Southern California - Marine Shells of the Californian Province*, by **David P. Berschauer and Roger N. Clark**. Covering the majority of the marine mollusks from Point Conception, California to Punta Eugenia, Baja California Sur, Mexico. This is the first field guide published on this biogeographical province in forty years, and a must have for every collector. Available exclusively through the San Diego Shell Club. Price \$30 plus 8% sales tax and shipping at actual costs (\$5.00 in the USA). PayPal to SDShellClub@gmail.com





New publication: Treasures of the Sea, The Unique Seashells of California, by Murray Kaufman and Paul Kanner. This landmark publication depicts the signature shells of California through outstanding photographs of exceptional specimens from important collections and fantastic *in situ* images of many of the living shells. Included in the text are descriptions of behaviors, habitats and geographic range never before published. An important resource for all shell collectors, this creative and artistic work will also be appreciated by anyone who loves the marine world. Sponsored by the San Diego Shell Club, the book is available August, 2018 and it can be purchased via their website for \$35 plus 8% sales tax and shipping at actual costs (\$5.00 in the USA). PayPal to SDShellClub@gmail.com



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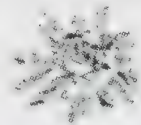
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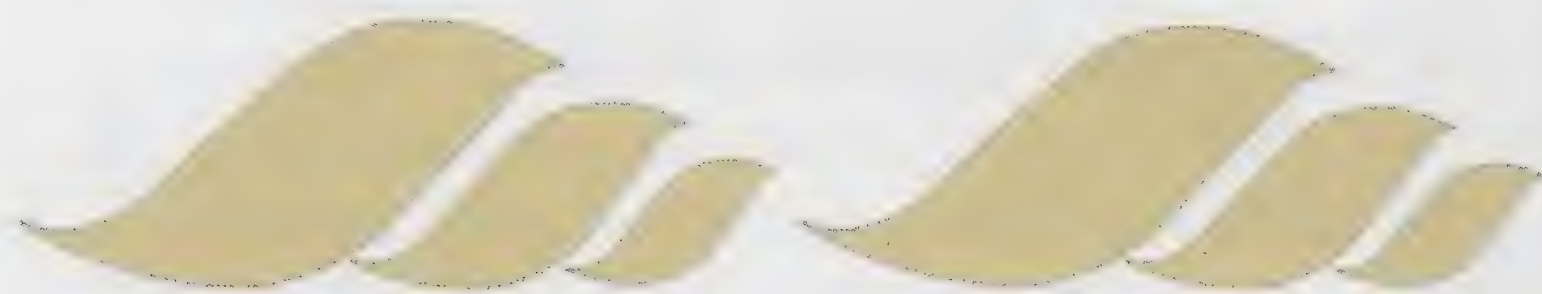
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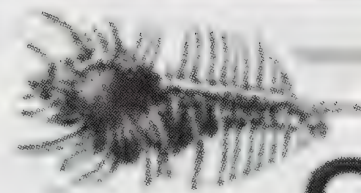
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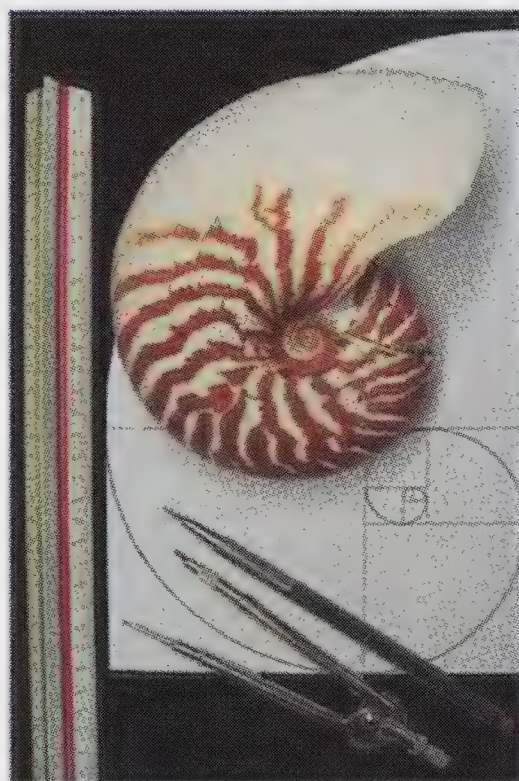
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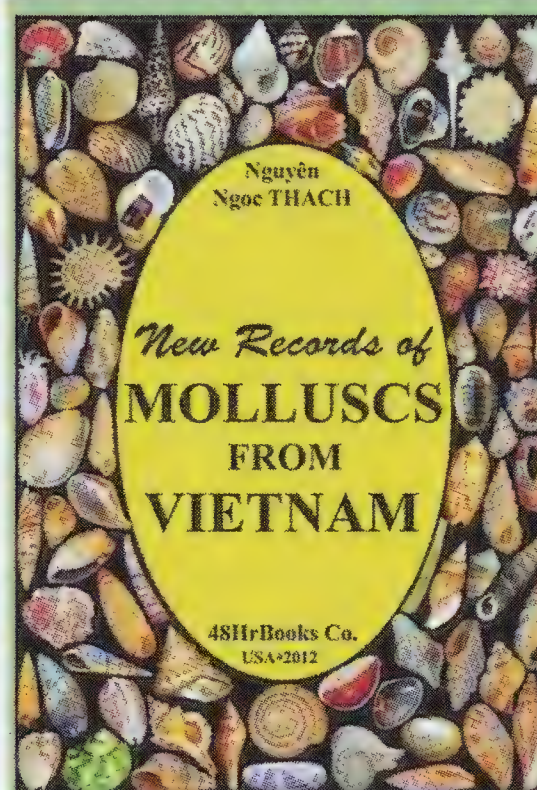
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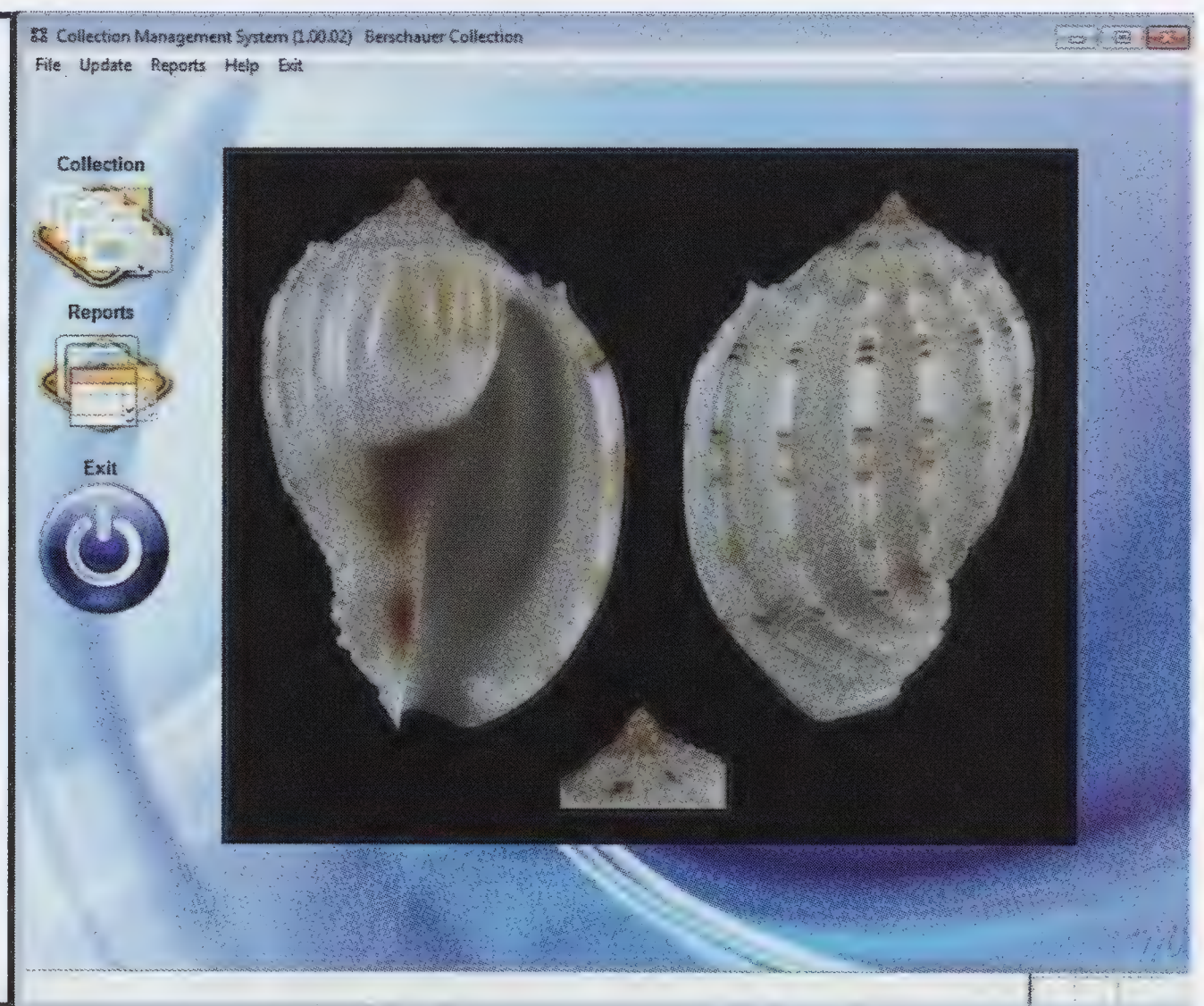
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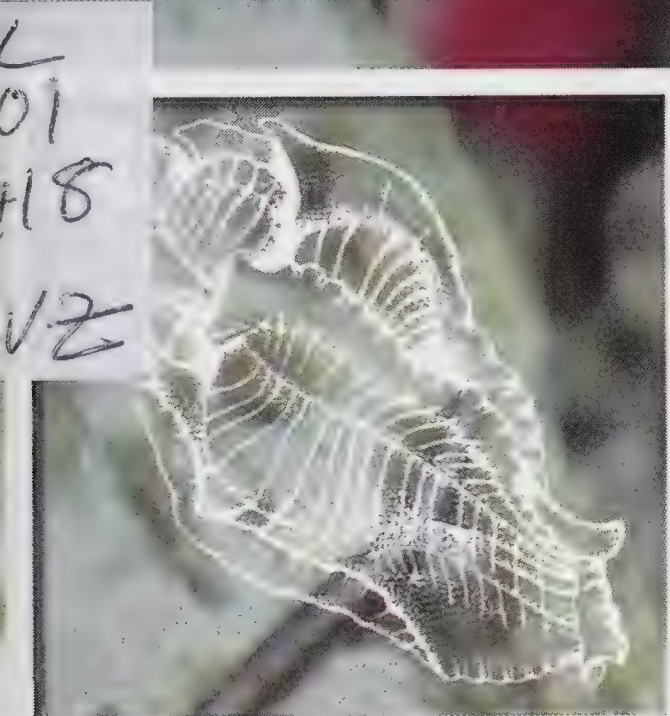
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THE Festivus

Vol. 50(4)

November 2018



Deep water Alaskan gastropods

Cuban *Chondropometes* landsnails

Fossil *Cassis* from southern Florida

***Altivasum* from southwestern Australia**

Quarterly Publication of the San Diego Shell Club



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: 50

November 2018

ISSUE 4

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Club meetings are held on the third Thursday or Saturday of the month, except April, September and December, at either 7:30 p.m. in Room 104, Casa del Prado, Balboa Park, San Diego, or at 12:00 noon at other locations as noticed on the Club's website.

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FRONT COVER:

Specimen of *Boreotrophon multicostatus* (Eschscholts, 1829) in situ in shallow water in Chiniak Bay, Kodiak island, Alaska. Photo by Roger N. Clark, used with permission. (Cover artistic credit: Rex Stilwill).

MISSION STATEMENT

The San Diego Shell Club was founded in 1961 as a non-profit organization for educational and scientific purposes. More particularly to enjoy, study and promote the conservation of Mollusca and associated marine life through lectures, club meetings and field trips. Our membership is diverse and includes beginning collectors, scientists, divers, underwater photographers and dealers.

THE FESTIVUS is the official quarterly publication of the San Diego Shell Club, Inc. and is issued as part of membership dues in February, May, August and November. *The Festivus* publishes articles that are peer reviewed by our volunteer Scientific Peer Review Board, as well as articles of general interest to malacologists, conchologists, and shell collectors of every level. Members of the Peer Review Board are selected to review individual articles based upon their chosen field of expertise and preference. Available by request or on our website are:

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Notes on two Alaskan Volutopsiinae (Gastropoda: Buccinidae) with corrected type localities

Roger N. Clark

Santa Barbara Museum of Natural History, Research Associate, 2559 Puesta Del Sol, Santa Barbara, California 93105; Mailing address: 3808 Pinehurst Drive, Eagle Mountain, Utah 84005: insignis69@gmail.com

ABSTRACT *Pyrulofusus harpa* (Mörch, 1857) and *Volutopsius castaneus* (Mörch, 1857) were described from Sitka, Alaska, however no specimens of either species have been found at Sitka, nor indeed anywhere in the eastern Gulf of Alaska. It seems more likely that the types of both species came from Kodiak, where both species are frequently found. The type localities for both species are herein corrected.

KEY WORDS Alaska, Taxonomy, Volutopsius, Pyrulofusus, Buccinidae, Sitka

INTRODUCTION

During the years of Russian colonization of Alaska, from 1774 to 1867, numerous natural history specimens were collected and sent to Europe for identification and description. Among these were many species of mollusks. Two of these, species of “Buccinids” were delivered into the hands of Swedish malacologist Dr. Otto Andreas Lawson Mörch, who described a new subgenus *Volutopsius*, for the North Atlantic *Strombus norwegicus* Gmelin, 1791, and his two new species from Alaska; *Fusus (Volutopsius) castaneus* Mörch, 1857 and *Fusus (Volutopsius) harpa* Mörch, 1857. Later, in 1869, Dr. Mörch described the genus *Pyrulofusus* for the sinistral *Fusus (Volutopsius) harpa*, and the very similar Arctic species *Fusus deformis* Reeve, 1847.

Although the identities of Mörch’s species are well established, the location of Mörch’s types were not. An inquiry to the Museum of Natural History in Copenhagen, Denmark (MNHD), the published repository of the type specimens (Oldroyd, 1927), resulted in an extensive search that failed to locate the types or any material

from the type locality (Dr. Tom Schiotte, personal communication, 31 May, 2018). Only two lots (three specimens) of *Volutopsius castaneus* and no *Pyrulofusus harpa* were found. One specimen has a label that reads “Frühere Russisch-Amerikanische Besitzungen”(former Russian-American Possession), the label for the other two specimens reads “Insel Kadjak, Pawlowscher Hafen” [Kodiak Island, (Saint) Paul Harbor], these were received from the museum at Saint Petersburg, Russia in 1897.

An inquiry was also sent to the Zoological Museum at Hamburg, Germany, where the Romberg collection, from which the types came, was said to be housed (Oldroyd, 1927), and after much searching, the types of both species were located (Dr. Bernhard Hausdorf, personal communication. 29 August, 2018).

A search of North American Museum collections (USNM, RBCM, LACM, SBMNH, CAS, UAM) as well as my own extensive collection of Alaskan mollusks revealed no specimens of either species from the stated type locality of Sitka, Alaska. Indeed in many expeditions to Southeastern Alaska in general,

and Sitka in particular, no specimens of either species were found. An inquiry to ADFG biologists Aaron Baldwin (formerly of Sitka) and Scott Walker (Ketchikan) confirmed that no specimens are known from the Sitka region, or indeed anywhere in southeastern Alaska. A literature search also confirmed that no specimens are known from the eastern Gulf of Alaska (Dall, 1921) listed both species from the Pribilof, Aleutian and Kodiak Islands. Bernard (1970) listed *P. harpa* [as *P. deformis* (Reeve, 1847)] from British Columbia, based no doubt on its proximity to the type locality, as no specimens are known from British Columbia.

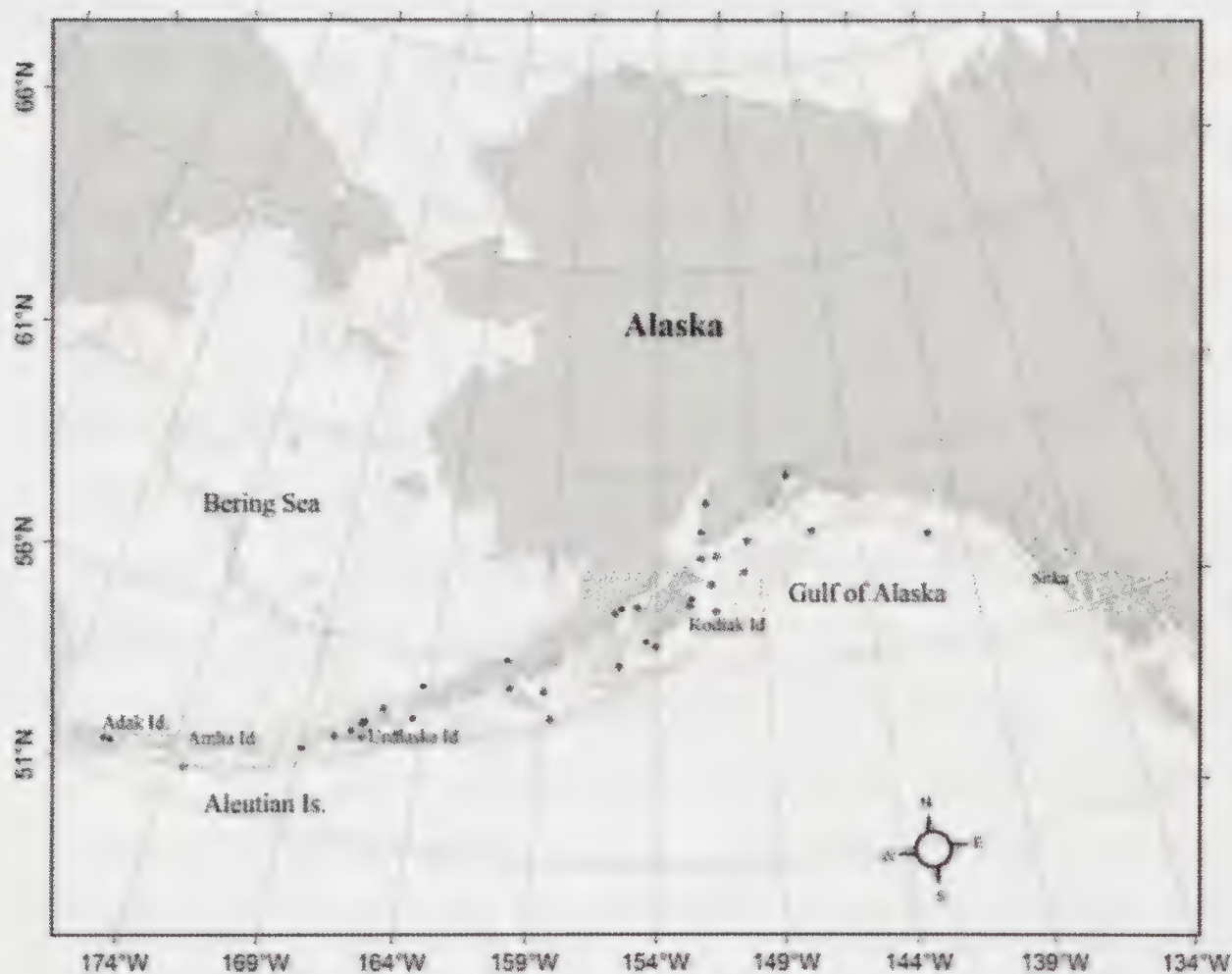


Figure 1. Map, Gulf of Alaska. • = *V. castaneus*; * = *P. harpa*.

Baxter (1987) listed *P. harpa* (as *Volutopsius harpa*) from Prince William Sound, Kodiak and the Aleutian Islands as well as the Cook Inlet, and Kenai Peninsula area, and Kessler (1985) recorded *V. castaneus* from north and south of the Alaska Peninsula, and distinguished it from the similar but distinct *Volutopsius stefanssoni* Dall, 1919. Kessler also recorded *P. harpa* from south of the Alaska Peninsula.

Novo-Archangelsk (New Archangel, now Sitka) was the capital of Russian America from 1804 to 1867. However Kodiak was the capital of

Russian America from 1784 to 1803 (Chevigny, 1965), and the type specimens were undoubtedly collected in this region where both species are uncommon in shallow water. For this reason, it is proposed that the type localities for both *Volutopsius castaneus* and *Pyrulofusus harpa* be amended, and corrected from Sitka to Kodiak.

SYSTEMATICS

Buccinidae

Volutopsiinae Habe & Sato, 1973

Genus: *Volutopsion* Habe & Ito, 1965

Type species: *Fusus (Volutopsius) castaneus* Mörch, 1857

Diagnosis. Shells relatively large, 10-14 cm; calcitic, often producing axial lamellae; nucleus relatively large, bulbous; aperture large, more than $\frac{1}{2}$ to $\frac{3}{4}$ of shell height; periostracum lacking. Operculum smaller than aperture, with terminal nucleus. Radula: Rachidian tooth with 5-7 denticles, lateral teeth with two denticles.

Volutopsion castaneus (Mörch, 1857)
(Figures 2A - 2F)

Type: ZMH 40073

Type locality. Sitka (in error). Amended to: USA, Alaska, Kodiak Island, Chiniak Bay (57°47'N, 152°26'W).

Description. Translation from Oldroyd (1927): "Shell ovate, thin, smoothish, spire projecting, apex obtuse; six convex whorls, divided by a profound suture, with plications of growth not regularly arranged, the last one very large; aperture large, oblong; columella slightly sinuate and barely callous; short broad tail (canal) subcurvate; outer lip simple; cheeks milky-white, subrosy".

Extended description: Length to 10 cm (type 69.5 mm; largest examined 83.0 mm, RNC 4707), aperture about $2/3$ to $3/4$ of shell height; nuclear whorls purplish; axial pleats irregular, sometimes forming low, varices. Color uniformly dark brown, orange-brown, tan or rarely white. Radula: rachidian tooth with five denticles, three central denticle subequal in length, two outer denticles much longer and heavier. (Figure 3L)

Distribution. A shallow water, near-shore species found in the Bering Sea, along the north side of the Alaska Peninsula (Kessler, 1985), along the Aleutian Islands, west to Adak Island [$54^{\circ}44'N$, $176^{\circ}30'W$ (RNC 4801)], Prince William Sound (Baxter, 1987), western Gulf of Alaska, along the south side of the Alaska Peninsula, East to Cook's Inlet and the Kenai Peninsula, and at Kodiak Island. Also may have a disjunct distribution, at Kamchatka (Kantor, 1990). Bathymetric range: 1-90 m.

Habitat. Lives on both sandy/muddy bottoms and on gravel and rocky bottoms, often on the sides of cobble and boulders, and in *Modiolus modiolus* beds, at depths of 1-35 m. Rarely taken below 50 m.

Notes: *Volutopsis castaneus* forms a complex with the Arctic *Volutopsius stefanssoni* Dall, 1921, which is often erroneously synonymized with it, but is distinct. *Volutopsius stefanssoni* is larger (length to 130+ mm), heavier shell, typically with a stronger shoulder, and is much more prone to developing laminae or axial knobs. Additionally it has orange nuclear whorls, and the rachidian tooth of the radula has five subequal denticles. *Volutopsius stefanssoni* occurs from the Arctic Ocean south the Pribilof Islands, it is an offshore species typically found at 70-140 m (20-80 m+ in the Arctic) on muddy bottoms. *Volutopsis simplex* (Dall, 1907) may be distinct species or subspecies, or merely a

smooth form of *V. stefanssoni*, it occurs in the western Bering Sea, from Kamchatka south to Hokkaido, Japan, and east to the near Islands, at the western end of the Aleutians. The species resembles *V. stefanssoni*, in its orange-brown shell and pink-orange nuclear whorls, but lacks sculpture and is typically more slender. Kantor (1990) considered *V. stefanssoni* a synonym and *V. simplex* a variety of *V. castaneus*. The radula of *V. simplex* is unknown to me. A fourth (as yet undescribed) species occurs sympatricly with *V. castaneus* along both sides of the Alaska Peninsula, and in the easternmost Aleutians. The species is larger, up to 140 mm, more slender with a spire half of shell length. The rachidian tooth of the radula of the undescribed species has seven denticles, five slender, widely spaced central denticles flanked by a much longer outer denticle on each side. *Volutopsion trophnius* Dall, 1902 is also a member of this complex, it is distinguished by its numerous axial lamellae. It is found only along the shelf break NW of the Pribilof Islands.

Genus: *Pyrulofusus* Mörch, 1869

Type species: *Fusus deformis* Reeve, 1847.

Diagnosis. Large, relatively thin shells with very short spire and large body whorl; may be sinistral or dextral; nucleus very large, smooth, rather flat-topped; spiral sculpture usually prominent, axial sculpture of large, often obscure folds; outer lip expanded and thickened. Periostracum thin, dehiscent; operculum much smaller than aperture, with a terminal nucleus.

Pyrulofusus harpa (Möorch, 1857)
(Figures 2G - 2K)

Type: ZMH 40071

Type locality. Sitka (in error). Amended to: USA, Alaska, Kodiak Island, Chiniak Bay ($57^{\circ}47'N$, $152^{\circ}26'W$).

Description. Large, sinistral shell (type 84.8 mm; largest examined 155 mm, RNC 4379), ovate, dull blueish-white; apex obtuse; aperture very large; five whorls divided by a deep suture; axial sculpture of regular oblique costae, spiral sculpture of coarse, flat-topped cords with broad interspaces.

Distribution. Prince William Sound (Baxter, 1987), Northern Gulf of Alaska 60°03' N, 147°03.96' W [(UAM 2321)], east to near Yakutat [59°24' N, 140°28' W (UAM Inv 2327)], Western Gulf of Alaska, Kenai Peninsula, Cook's Inlet and Kodiak Island, and along the Aleutian Islands, West to Adlai Island, [51°57' N, 173°40' W (RNC 4563)].

Habitat. Lives on rocky, and sandy/mud bottoms at depths of 2-506 m.

Notes: This species is often confused with the Arctic *Pyrulofusus deformis* (Reeve, 1847) from which it differs in its coarser sculpture, much smaller central denticle on the rachidian tooth of the radula, and distribution (Figure 3M).

Cowan (1965) described a mature egg capsule as large, hemispherical, 39 mm in diameter and 21 mm in height, bearing a single near-hatchling 19.5 mm in length, with no nurse eggs.

ACKNOWLEDGEMENTS

I am grateful to the following people: Dr. Bernard Hausdorf (Zoological Museum, Hamburg, Germany) and Dr. Tom Schiotte (Museum of Natural History, Copenhagen, Denmark) for searching their respective institutions for the Mörch types; Scott Walker (Alaska Department of Fish and Game, Ketchikan) and Aaron Baldwin (Alaska Department of Fish and Game, Juneau) for sharing their knowledge of SE Alaskan Buccinidae distribution; Nora Foster (Fairbanks,

Alaska), for help accessing the University of Alaska Museum database; Lindsey Groves (NHMLAC); Dr. Daniel Geiger (SBMNH), for taking SEM micrographs; and to Robert R. Lauth (Alaska Fisheries Science Center, Seattle) for providing a map of the Gulf of Alaska, and providing additional data.

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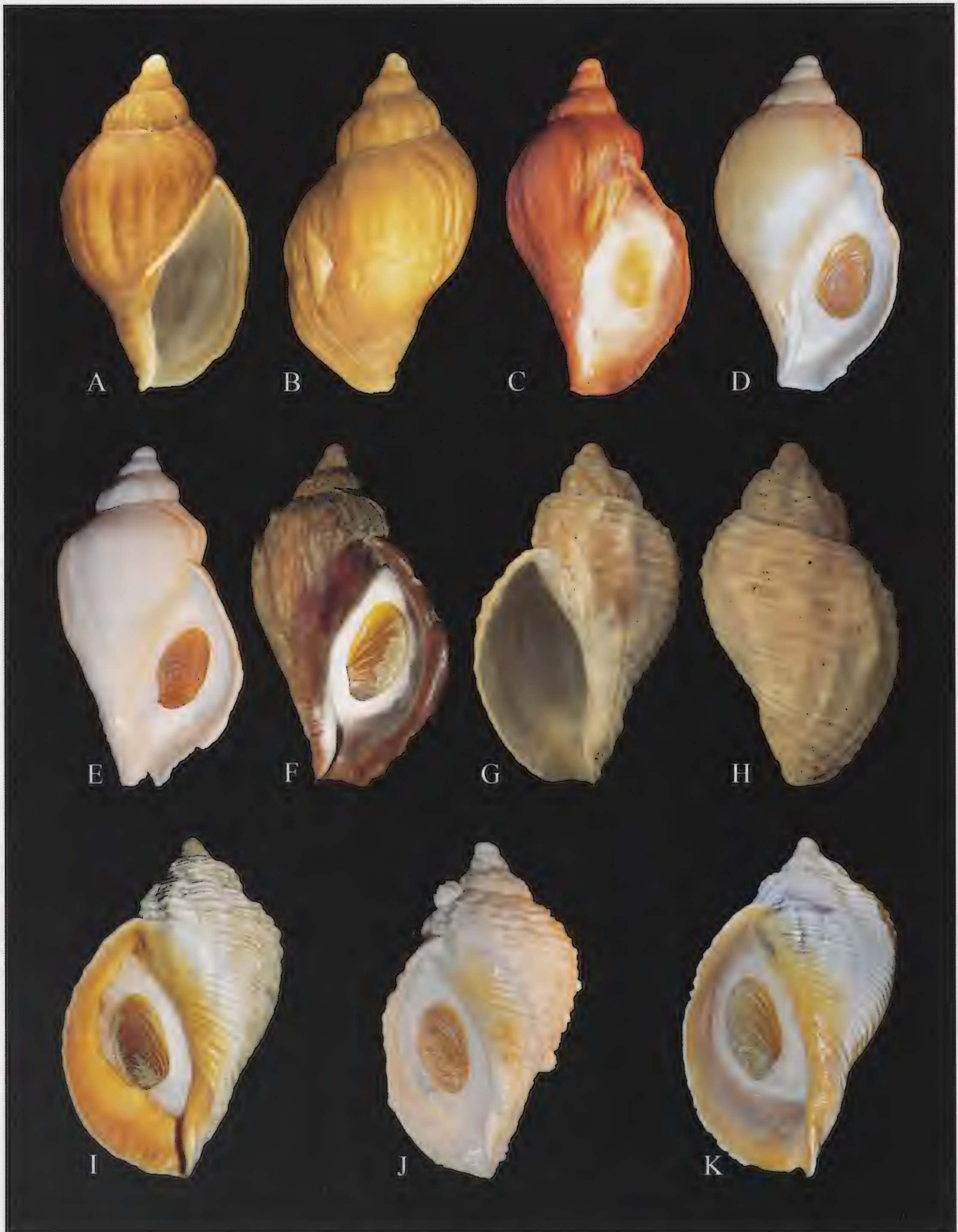


Figure 2. *Volutopsis castaneus* A & B = Holotype ZMH 40073; C = RNC 4184, Kenai Peninsula, Seldovia, 1 m, 65.9 mm; D = Chiniak Bay, Kodiak Island, 2-5 m, 72.9 mm; E = Chiniak Bay, Kodiak Island, 2-5 m, 79.7 mm; F = RNC 4801, Blind Cove, Adak Island, Aleutian Islands, 13 m, 76.2 mm; *Pyrulofusus harpa* G & H = Holotype; I = RNC 4180, East of Afognak Island, 120 m, (NMFS 21-197701-20), 132.6 mm; J = RNC 4378, Chiniak Bay, Kodiak, 15 m, 109.5 mm; K = RNC 4563, Amlia Island, Aleutian Islands, 100 m, (NMFS 94-200201-39), 127.4 mm.

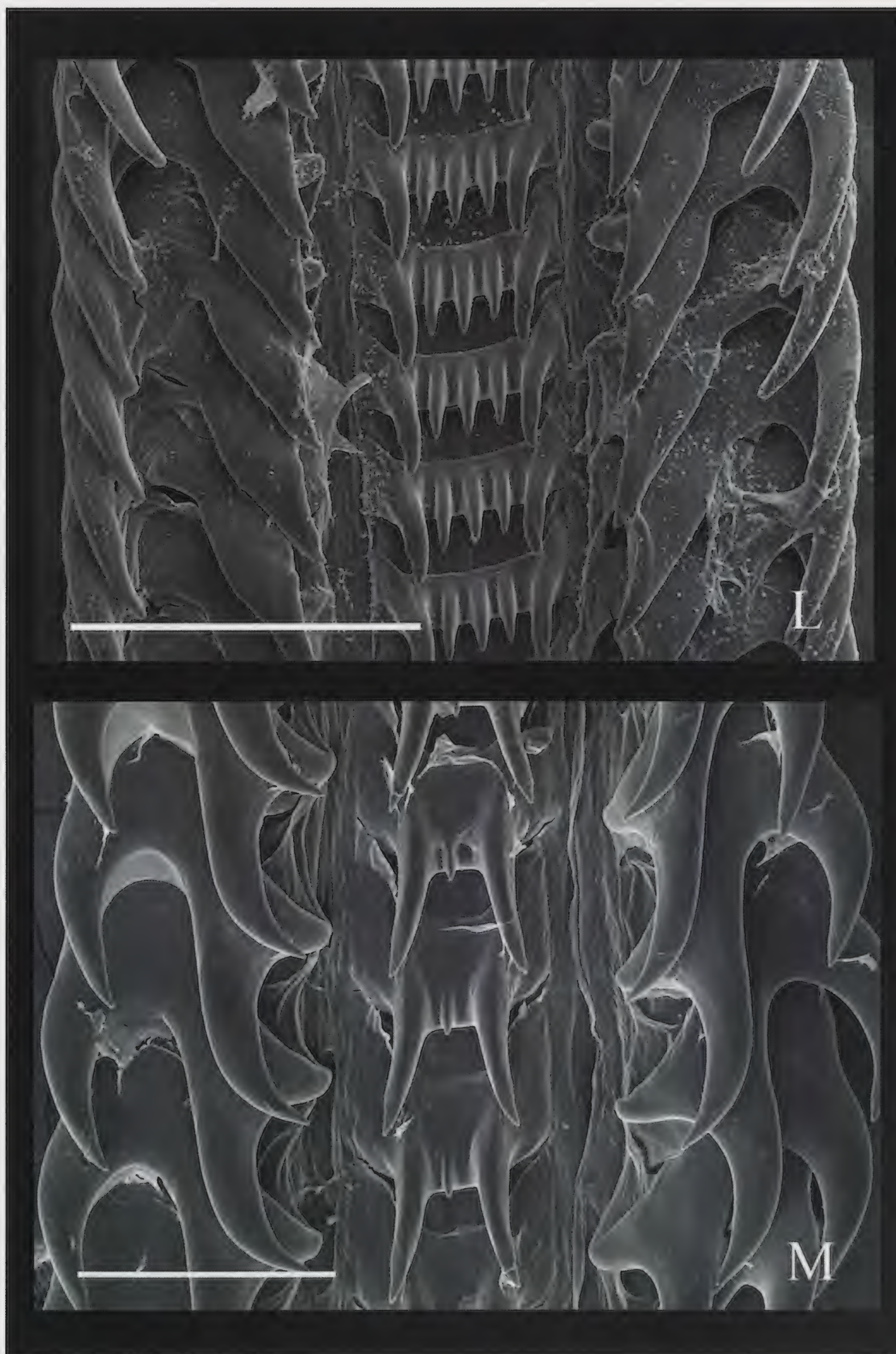


Figure 3. **L** = Radula. *Volutopsis castaneus*, Seldovia, Alaska, 2 m, RNC 4184; bar = 0.5 mm. **M** = Radula. *Pyrulofusus harpa*, RNC 4209, South of Unimak Pass, Aleutian Islands, 124 m (NMFS 95-199401-7); bar = 0.25 mm.

The genus *Chondropometes* (Littorinoidea: Annulariidae) from the western karstic hills of Cuba

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ABSTRACT The named taxa of *Chondropometes* land snails from western Cuba Annulariidae are reviewed and illustrated. Following a discussion of the taxonomic work to date and the morphology, distribution and ecology of these land snails, the authors make suggestions for future work based upon shell morphological features and geographic isolation of various populations.

KEYWORDS Mollusca, *Chondropometes*, land snails, Cuba, karst

INTRODUCTION

Taxonomic background 1920-2006.

In 1863 Ludwig Pfeiffer published the description of *Chondropoma vignalense* based on specimens sent by Charles Wright. This description was part of the series of papers titled “Zur Molluskenfauna von Cuba” printed under the famous Malakozoologische Blätter from Cassel in Germany. *C. vignalense* was placed in the family in the late 19th century, and later became the type species for the genus *Chondropometes*.

The Annulariidae family or “New World Cyclostomoid mollusks” was established by John B. Henderson and Paul Bartsch in 1920. The keys and grouping to the genera and subgenera were based mainly on external morphological characteristics of the shells. They wrote:

“To further refine the classification we have created a generous number of subgenera based almost wholly upon shell characters, using especially the “breathing apparatus” and the

sculptural features in their various combinations. A final division under the subgenera carrying the classification to its ultimate rational end has been adopted by designating specific groupings wherever obvious similarity in form has made such assemblages useful for systematic study. Among the numerous shell characters employed in our classification we have considered the most important the presence or absence of punctures or slits within or on the edge of the aperture, and when present, the nature of such devices for enabling the animal to obtain air when the operculum is withdrawn or seals the aperture. This character we believe to be of less taxonomic value than that of the opercula but of paramount importance among the shell characters. Among the Annulariidae we have found no important radular differences and no range in nuclear characters worthy of note. A sufficiently large number of species from the different genera have already been described anatomically, or observed by ourselves, to warrant our belief that no fundamental anatomical differences exist within the scope of the entire family. The length of the proboscis seems to be merely relative. The division of the

foot by a longitudinal groove into two independently functioning muscular masses is always present, but the peculiar method of progression caused thereby is merely exaggerated in those species where the foot is short and less apparent when the foot is longer" (Henderson & Bartsch, 1920).

Chondropometes was defined to be a turbate shell with spiral sculpture not confined to the umbilicus, and *Chondrothyroma* was distinguished as a turbate shell with a spiral sculpture absent except in the umbilicus. Both taxa were placed as subgenera inside the subfamily Chondropominae, and related to the genera *Chondropoma* (Pfeiffer, 1847) and *Chondrothyra* (Henderson & Bartsch, 1920). In fact, Henderson and Bartsch created different groups of taxa inside the Annulariidae based on the diversity of operculum structures, and the "flat proteinaceous "chondroid" operculums with little or no secondary calcification" which were placed in Chondropomatinae (Watters, 2006).

The genus *Chondropometes* was described as: "Shell of turbate form, openly umbilicated, marked by axial and spiral threads. Operculum typically chondropomoid with the nucleus sub central". Pfeiffer, incorrectly identifies Gundlach as the collector of the type species of the subgenus-*Chondropoma*, *C. vignalensis* specimens, when in fact it was Wright as it appears on the original publication. (Henderson & Bartsch 1920; Watters, 2006.)

The genus *Chondrothyroma* was described as: "Shell turbate, openly umbilicated, marked by axial ribs only, excepting the umbilical wall, which shows strong spiral threads. The breathing pore is on the parietal wall, a little behind the broadly expanded peristome, close to the posterior angle of the aperture. Operculum typically Chondropomoid with subcentral

nucleus". The type species of the subgenus-*Cyclostoma*, is *C. sagebieni* (Poey, 1857).

In 1938, the Cuban malacologist Carlos de la Torre together with Paul Bartsch published a volume dedicated to the landshells of the subfamily Chondropominae; Henderson died in 1923 leaving their project unfinished. In their work, they reinforced the idea that *Chondropometes* and *Chondrothyroma* subgenera were different based essentially on the presence or absence of the breathing device on those turbate shells, which in the second subgenus was considered not a slit but a puncture. However, both taxa were placed under the genus *Chondropometes* referring to the type species as from Wright in Pfeiffer (1863) rather than as from Gundlach. The realignment of the subgenera was mainly based on the discovery of species without a breathing pore: *C. (Chondrothyroma) scopulorum perplexum* and *C. (Chondropometes) magnum magnum*.

The genus *Chondropometes* was then described as: "Shell of turbate form, openly umbilicated, marked by axial and spiral threads. Lip simple or double. Breathing pore present or absent. Operculum subcircular, multispiral with the inner part of the whorls covered with a heavy calcareous callouslike deposit".

In 1942, Torre and Bartsch still maintained their systematic arrangement for the genus *Chondropometes*. However, in 1949 Morris K. Jacobson published a short note on the three subspecies of *Chondropometes magnum* criticizing the validity of the distinguishing criteria used by de la Torre and Bartsch to divide them, questioning the "adnateness or soluteness of the last whorl" given by those authors as an appropriate diagnostic characteristic. Two years later in 1951, Mario Sánchez-Roig published the last two *Chondropometes* subspecies: *Chondropometes*

torrei colmenaris, and *Chondropometes segregatum palmae*.

For fifty five years there have been no publications on *Chondropometes* taxonomy; with only a few mentions of terrestrial mollusk inventories from Pinar del Rio province localities (*i.e.* Espinosa, 2004). In 2006, G. Thomas Watters published a huge work revising the Annulariidae higher taxa and cataloging all the Caribbean taxa previously described for that family, without recognizing the two subgenera previously assigned to the genus. Watters added to the former generic description of *Chondropometes* that “the lip can be either narrow or expanded, and that the axial sculpture may become lamellate.”

Shell Features, Distribution and Ecology.

The distribution of the genus is restricted to Sierra de los Órganos, the western section of the Guaniguanico mountain range. From Guane to Sierra de la Güira is by far the richest region of Annulariidae endemics (Watters, 2006) where various species are found in several localities. The distribution of species from both subgenera seem to overlap only in the area encompassed by Sierra Guacamayas, Sierra de Galalón and Sierra de San Andrés, all of which are in Consolación del Norte. Fontenla and López wrote about the biogeography of the genus, providing some insights into the distribution of these snails. (Fontenla & López, 2007)

Sexual dimorphism is apparent in the species of *Chondropometes* and can be seen in a wide array of rib sculptures, which can be significant or just feeble, covering entire or part of the opened coiling shells. Decollation, or apex rupture, commonly occurs in *Chondropometes* species, but explanations of this distinctive character are still speculative. The apex can display grain structures and lips can be

expanded in some species more than others. (Watters, 2006)

As a general rule, *Chondropometes* species are entirely calciphiles and more often found in shady or humid places than sunny cliffs. Many species are found while aestivating; hanging on their mucus threads, in dark crevices, cavern thresholds or caves with low light.



Figure 1. *Chondropometes magnum magnum* hanging from its own thread while aestivating. “Hoyo de los Helechos” (Fern’s Hole), from San Carlos Valley area.

Chondropometes species such as *vignalense* and *torrei* have many infraspecific taxa based mainly on color differences and geographic ranges. These criteria do not always hold up under scrutiny. For example, *C. v.*

bruneocinctum and *C. v. venerabile* morphs on Queque (spongy rock) are extremely close, and there simply is not enough morphological difference to support subspecific splitting.

In Viñales, there are several color morphs were given various *C. vignalensis* subspecies names, which is a similar situation to *C. torrei* ssp. over numerous expanses of its distribution range (Lajonchere, 2013). The same source cited noted consistency for *C. vignalensis* on its smaller shell size, sculpture features and creamy base coloration in the ranges west of Sierra del Infierno hills, and noted larger shells with a wide range of color morphs eastward. As is generally the case with any *Chondropometes* species, the specimens occurring on small mogotes are smaller than the ones occurring at higher altitudes and in larger Sierra areas. Smaller and higher spire shells were found by the senior author in Pico Grande and Colmillo de la Vieja, East San Andres hills system, while in the west portion of the main range, larger specimens showing more color morphs were found. Additionally, one can find a “*flammlabre*” typical peristome coloration in *minaense* locality where it was believed to harbor only “pale yellow peristome shells”.

Chondropometes latilabre can be found displaying many different color morphs in the same locality that perhaps was the reason why those morphs weren’t described as different subspecies. Curiously, Torre & Bartsch didn’t mention all the color range of *latilabre* or the scarce banding present in darker morphs.

Other taxa such as *C. scopulorum* seem to be more supported by geographic distance. For example, *C. s. cumbrense* actually inhabits Sierra del Rosario, east of San Diego River.

Most of the *C. concolor* subspecies are similar and smaller in size as a general rule because

they occur in small mogote formations very near to each other (the larger taxa is *C. c. concolor* which inhabits the Pico Chico range). It is the author’s opinion that the geographic distance and phenotypic variation didn’t support that many species in the area. The sculpture and operculum of *C. exquisitum* is the most similar to *C. concolor*, which perhaps is a sister species, alternatively *C. concolor* may be a subspecies of *C. exquisitum*.

Despite Jacobson’s assumption in 1949, *C. magnum signae* could represent a valid subspecies because it inhabits a different geographic range (the Cabezas hills) in addition to having dissimilar shell features from the other subspecies.

C. sagebieni sagebieni and *C. s. portalesense* are also separated geographically, and it is possible that the other northern and southern subspecies under *sagebieni* are just smaller in size due to living on small isolated mogotes.

A similar scenario of minor variations occurs with *C. sacharinum* subspecies, which occur on a continuous mountain range from Sierra de Pan de Azúcar (*C. s. sacharinum*) to Sierra del Martillo (*C. s. rubicollum*).

The nucleus area for *C. segregatum* are very close geographically (Hoyo del Guama, Kilómetro 14 and Cayos de San Felipe), with very similar shells and are considered the largest of the species. Populations from Herradura and south Mogote of Pico Chico are smaller in size, however it could be concluded that they belong to the same species. It appears from the geographic distances and proximity of the localities that there are only two subspecies.

An anti-predator strategy mentioned for these annularids is hanging from mucus threads. (González-Guillén, 2008) Abraham S. H.

Breure collected data and photographs from some authors (including field observations and photographs by González-Guillén), and wrote about malacophagy and dangling snails mentioning among those annularids the genus *Chondropometes* (Breure, 2011).

CONCLUSIONS

The subspecies of *Chondropometes* predominantly described by Torre and Bartsch are based on shell features and topographic data, which are dubious or unreliable. Nevertheless, the staggering amount of work done by these authors in compiling all the known Cuban Annulariidae is something that no other malacologist since has replicated, and is an invaluable source of information about incipient speciation processes. (Watters, 2006). Shell size and coloration is not sufficient alone to name taxa of sympatric populations of these snails, and separate taxa should be based upon stronger criteria and must include both morphological features as well as geographic isolation.

In-print Taxa 1842-1951.

Family: **Annulariidae** (Henderson & Bartsch, 1920)

Subfamily: **Chondropomatinae** (Henderson & Bartsch, 1920)

Genus: *Chondropometes* (Henderson & Bartsch, 1920)

Distribution: Sierra de los Órganos, Guaniguanico mountain range, Pinar del Río province.

Subgenus: *Chondropometes* (Henderson & Bartsch, 1920)

Species (denoted hereinafter by “•”):

- *latilabre* (d’Orbigny, 1842) (Figure 4F)
Distribution: From San Juan de Sagua at the Western end of Pan de Guajaibón, to the middle of its northern slope.



Figure 2. Live specimen of *C. latilabre* from Pan de Guajaibón.

- *torrei* (Bartsch, 1937)

Subspecies:

Chondropometes torrei torrei (Bartsch, 1937)

Distribution: Abra de Bejarano, Mogote Canalete, sur de la Sierra de San Andrés, Consolación del Norte. (Figure 5H)

Chondropometes torrei affine (Torre & Bartsch, 1938)

Distribution: Second Mogote south of the west end of Sierra de Guacamayas, Consolación del Norte.

Chondropometes torrei alveare (Torre & Bartsch, 1938)

Distribution: Mogote Colmena de Piedra, southwest of Sierra Galalón, Consolación del Norte.

Chondropometes torrei antonitense (Torre & Bartsch, 1938)

Distribution: Hoyo Corto de San Antonio, southwest of Sierra de San Andrés, Consolación del Norte.

Chondropometes torrei antoniense (Torre & Bartsch, 1938)

Distribution: Mogote de la Jagua, La Palma, Consolación del Norte.

Chondropometes torrei cingulatum (Torre & Bartsch, 1938) (Figure 5I)

Distribution: Ensenada de la Ayúa and Ensenada del Zumbido, Sierra de San Andrés, Consolación del Norte.

Chondropometes torrei collumelare (Torre & Bartsch, 1938) (Figure 6A)

Distribution: Colmillo de la Vieja, northeast side of Sierra Guacamayas, Consolación del Norte.

Chondropometes torrei colmenaris (Sánchez Roig, 1951)

Distribution: Colmena de Piedra, east of Hoyo Negro, southwest Galalón, Consolación del Norte.

Chondropometes torrei flammilabre (Torre & Bartsch, 1938) (Figure 5D)

Distribution: From Pico Grande to west of Ensenada del Zumbido, Sierra de San Andrés, Consolación del Norte.

Chondropometes torrei flavidum (Torre & Bartsch, 1938) (Figure 5F)

Distribution: Mogote located on the southeast end of Sierra Guacamayas and Mogote Largo, to the south of this, Consolación del Norte.

Chondropometes torrei gratiosum (Torre & Bartsch, 1938) (Figure 5G)

Distribution: Pinalito, southwestern part of Sierra de Galalón, Consolación del Norte.

Chondropometes torrei iosaturatum (Torre & Bartsch, 1938)

Distribution: Sitio de la Sierra de San Andrés, northeast San Andrés hills, Consolación del Norte.

Chondropometes torrei jaguaense (Torre & Bartsch, 1938)

Distribution: La Jagua, La Palma, Consolación del Norte.

Chondropometes torrei luteilabre (Torre & Bartsch, 1938)

Distribution: Puerto de San Andrés, extreme eastern end of Sierra de San Andrés, Consolación del Norte.

Chondropometes torrei minaense (Torre & Bartsch, 1938)

Distribution: Mogote de la Mina, extreme western of San Andrés hills, Consolación del Norte.

Chondropometes torrei pallidulum (Torre & Bartsch, 1938)

Distribution: Mogote Largo, which is the second Mogote southwest of Pico Chico, in Sierra Guacamayas, Consolación del Norte.

Chondropometes torrei rinconadense (Torre & Bartsch, 1938)

Distribution: Mogote Rinconada, close to east of Mogote de la Mina, Consolación del Norte.

• ***vignalense*** (Wright *in* Pfeiffer, 1863)

Subspecies:

Chondropometes vignalense vignalense (Wright *in* Pfeiffer, 1863)

Distribution: Southeastern end of Sierra de la Chorrera, Viñales.

Chondropometes vignalense azucarellum (Torre & Bartsch, 1938)

Distribution: Mogote Pan de Azúcar, Minas de Matahambre.

Chondropometes vignalense azucarensense (Torre & Bartsch, 1938)

Distribution: Pan de Azúcar, Minas de Matahambre [it should be Sierra de Pan de Azúcar].

Chondropometes vignalense bruneocinctum (Torre & Bartsch, 1938) (Figure 6B)

Distribution: Sierra Tumbadero (also known as El Queque), Viñales.

Chondropometes vignalense caponense (Torre & Bartsch, 1938)

Distribution: Mogote Capón, south of Chorrera, Viñales.

Chondropometes vignalense clappi (Torre & Bartsch, 1938) (Figure 6C)

Distribution: North end of Sierra de la Chorrera, Viñales.

Chondropometes vignalense celadense (Torre & Bartsch, 1938)

Distribution: Sierra de Celadas, west of Viñales.

Chondropometes vignalense fogonense (Torre & Bartsch, 1938)

Distribution: Mogote Fogón de los Negros, northeastern end of Sierra de la Chorrera, Viñales.

Chondropometes vignalense ignicolor (Torre & Bartsch, 1938)

Distribution: Hoyo Magdalena in Costanera de San Vicente, north Viñales.

Chondropometes vignalense infernale (Torre & Bartsch, 1938)

Distribution: Sitio del Infierno, southwest Viñales.

Chondropometes vignalense jarucense (Torre & Bartsch, 1938) (Figure 6D)

Distribution: Hoyo de Jaruco, a sink located on the high parts of the east side of Sierra de la Chorrera, Viñales.

Chondropometes vignalense lucifer (Torre & Bartsch, 1938)

Distribution: Sierra del Infierno, Viñales.

Chondropometes vignalense martillense (Torre & Bartsch, 1938)

Distribution: Cueva del Martillo, in the ridge that connects Sierra de Chichones and Sierra de Celadas-Sierra del Infierno, west of Viñales.

Chondropometes vignalense palmaritense (Torre & Bartsch, 1938)

Distribution: Mogote Palmarito, Viñales.

Chondropometes vignalense piadae (Torre & Bartsch, 1938) (Figure 6E)

Distribution: El Ancón, north of Sierra de Viñales.

Chondropometes vignalense poenitentis (Torre & Bartsch, 1938) (Figure 6F)

Distribution: From Mogote Dos Hermanos to Cuajani and from there to La Penitencia, Viñales.

Chondropometes vignalense puertecitense (Torre & Bartsch, 1938) (Figure 6G)

Distribution: Mogote Puertecitas, off the southeast end of Sierra de la Chorrera, Viñales.

Chondropometes vignalense venerabile (Torre & Bartsch, 1938)

Distribution: Hoyo de los Santos in Mogote El Queque, Viñales.

Subgenus *Chondrothyroma* (Henderson & Bartsch, 1920)

Species:

- *bellissimum* (Torre & Bartsch, 1938)
Distribution: Mogote del Bosque de Galalón.

- *concolor* (Torre & Bartsch, 1938)

Subspecies:

Chondropometes concolor concolor (Torre & Bartsch, 1938) (Figure 4B)

Distribution: Lowlands in the eastern part of Sierra Guacamayas, Consolación del Norte.

Chondropometes concolor carnicolor (Torre & Bartsch, 1938)

Distribution: Mogote located south-slightly southeast of Sierra Guacamayas, Consolación del Norte.

Chondropometes concolor fontei (Torre & Bartsch, 1938)

Distribution: Mogote de Fonte, southeast of Sierra Guacamayas, Consolación del Norte.

Chondropometes concolor magister (Torre & Bartsch, 1938)

Distribution: Between Galalón and Caiguanabo, Consolación del Norte.

Chondropometes concolor spe (Torre & Bartsch, 1938)

Distribution: South part of the hills collectively known as Mogotes de Fonte and Finca La Esperanza, southeast of Sierra San Andrés, Consolación del Norte.

• *eximium* (Torre & Bartsch, 1938)

Subspecies:

Chondropometes eximium eximium (Torre & Bartsch, 1938) (Figure 6H)

Distribution: Isabel María, southeast Sierra del Quemado.

Chondropometes eximium angusticulum (Torre & Bartsch, 1938)

Distribution: East side of Sierra de San Carlos, in front of southern end of Sierra de los Acostas.

Chondropometes eximium malleatum (Torre & Bartsch, 1938) (Figure 4D)

Distribution: West side of La Estrechadura, eastern Wall of southern end of Sierra de los Acostas.

• *exquisitum* (Torre & Bartsch, 1938)

Subspecies:

Chondropometes exquisitum exquisitum (Torre & Bartsch, 1938) (Figure 4C)

Distribution: From Sierra la Güira in San Diego de los Baños to Abra de Caiguanabo.

Chondropometes exquisitum cereum (Torre & Bartsch, 1938)

Distribution: East end of Sierra Guacamayas, Consolación del Norte.

Chondropometes exquisitum notatum (Torre & Bartsch, 1938) (Figures 4A, 4E)

Distribution: Near Cueva Oscura del Río Caiguanabo at Los Portales, San Diego de los Baños.

Chondropometes exquisitum punctolineatum (Torre & Bartsch, 1938)

Distribution: Mogote Grande, southwestern end of Sierra Guacamayas, Consolación del Norte.

• *magnum* (Torre & Bartsch, 1938)

Subspecies:

Chondropometes magnum elisabethae (Torre & Bartsch, 1938)

Distribution: Isabel María, northeast of Sumidero.

Chondropometes magnum magnum (Torre & Bartsch, 1938) (Figure 4G)

Distribution: Inner rim of Potrero de Luis Lazo, Sierra de los Acostas, Sierra de San Carlos and Sierra de Sumidero.

Chondropometes magnum signae (Torre & Bartsch, 1938) (Figure 4H)

Distribution: Mogotes east of Cabezas hills vicinity.



Figure 3. Live specimen of *C. magnum magnum* from San Carlos.

• *saccharinum* (Torre & Bartsch, 1938)

Subspecies:

Chondropometes saccharinum saccharinum (Torre & Bartsch, 1938) (Figure 5A)

Distribution: Sierra de Pan de Azúcar, Minas de Matahambre.

Chondropometes saccharinum rubicollum (Torre & Bartsch, 1938)

Distribution: Sierra del Martillo, west Viñales.

• *sagebieni* (Poey, 1858)

Subspecies:

Chondropometes sagebieni sagebieni (Poey, 1858) (Figure 5B)

Distribution: Sierra de Guane.

Chondropometes sagebieni disjunctum (Torre & Bartsch, 1938)

Distribution: Mogote from Punta de la Sierra, north of Guane.

Chondropometes sagebieni mendozense (Torre & Bartsch, 1938)

Distribution: Mendoza (today known as Isabel Rubio), Guane.

Chondropometes sagebieni parvum (Torre & Bartsch, 1938)

Distribution: Tenería and La Muralla, north of Los Portales, Guane.

Chondropometes sagebieni portalesense (Torre & Bartsch, 1938)

Distribution: Los Portales, Guane.

• ***scopulorum*** (Torre & Bartsch, 1938)

Subspecies:

Chondropometes scopulorum scopulorum (Torre & Bartsch, 1938)

Distribution: Southern part of Sierra de la Güira, San Diego de los Baños.

Chondropometes scopulorum cumbrense (Torre & Bartsch, 1938)

Distribution: south side of the west end of Sierra La Cumbre, San Diego de los Baños.

Chondropometes scopulorum perplexum (Torre & Bartsch, 1938)

Distribution: Mogote Colorado, on the east side of San Diego River, near San Diego de los Baños.

• ***segregatum*** (Torre & Bartsch, 1938)

Subspecies:

Chondropometes segregatum segregatum (Torre & Bartsch, 1938) (Figure 5C)

Distribution: Mogote east side of Kilómetro 14, between Pinar del Río and Viñales.

Chondropometes segregatum arangoi (Torre & Bartsch, 1938)

Distribution: Hoyo de Guamá, south Viñales.

Chondropometes segregatum felipense (Torre & Bartsch, 1938)

Distribution: Small Mogote ½ west of Kilómetro 14, also seems to inhabit on Cayos de San Felipe, south of Viñales.

Chondropometes segregatum lagunitasense (Torre & Bartsch, 1938)

Distribution: Las Lagunitas (we think is located on San Juan and Martínez vicinity).

Chondropometes segregatum laureani (Torre & Bartsch, 1938)

Distribution: Mogote de la Caja, west of Pinar del Río city.

Chondropometes segregatum mameyi (Torre & Bartsch, 1938)

Distribution: Mogote Mamey, the northern one of the two large limestone peaks off southwestern end of Sierra Guacamayas, Consolación del Norte.

Chondropometes segregatum palmae (Sánchez Roig, 1951)

Distribution: La Palma in Sumidero, Consolación del Norte.

Chondropometes segregatum sporadicum (Torre & Bartsch, 1938) (Figure 5E)

Distribution: Mogote de Quilla, Finca El Descanso, Entronque Herradura.

Chondropometes segregatum vallei (Torre & Bartsch, 1938)

Distribution: Tall Mogote located southwest of Kilómetro 14, between Pinar del Río city and Viñales area.

Important note on the taxa distribution areas given by Torre & Bartsch: The true Sierra Guacamayas geographically speaking is on the southern face of Sierra de San Andrés. The area that Torre and Bartsch called “Guacamayas” in their book is in fact what is known today as Sierra de Pico Chico in Consolación del Norte.

ACKNOWLEDGEMENTS

The authors are grateful to have received the support and assistance of Alena Reyes Fornet and Alba R. Guillén-Pérez.

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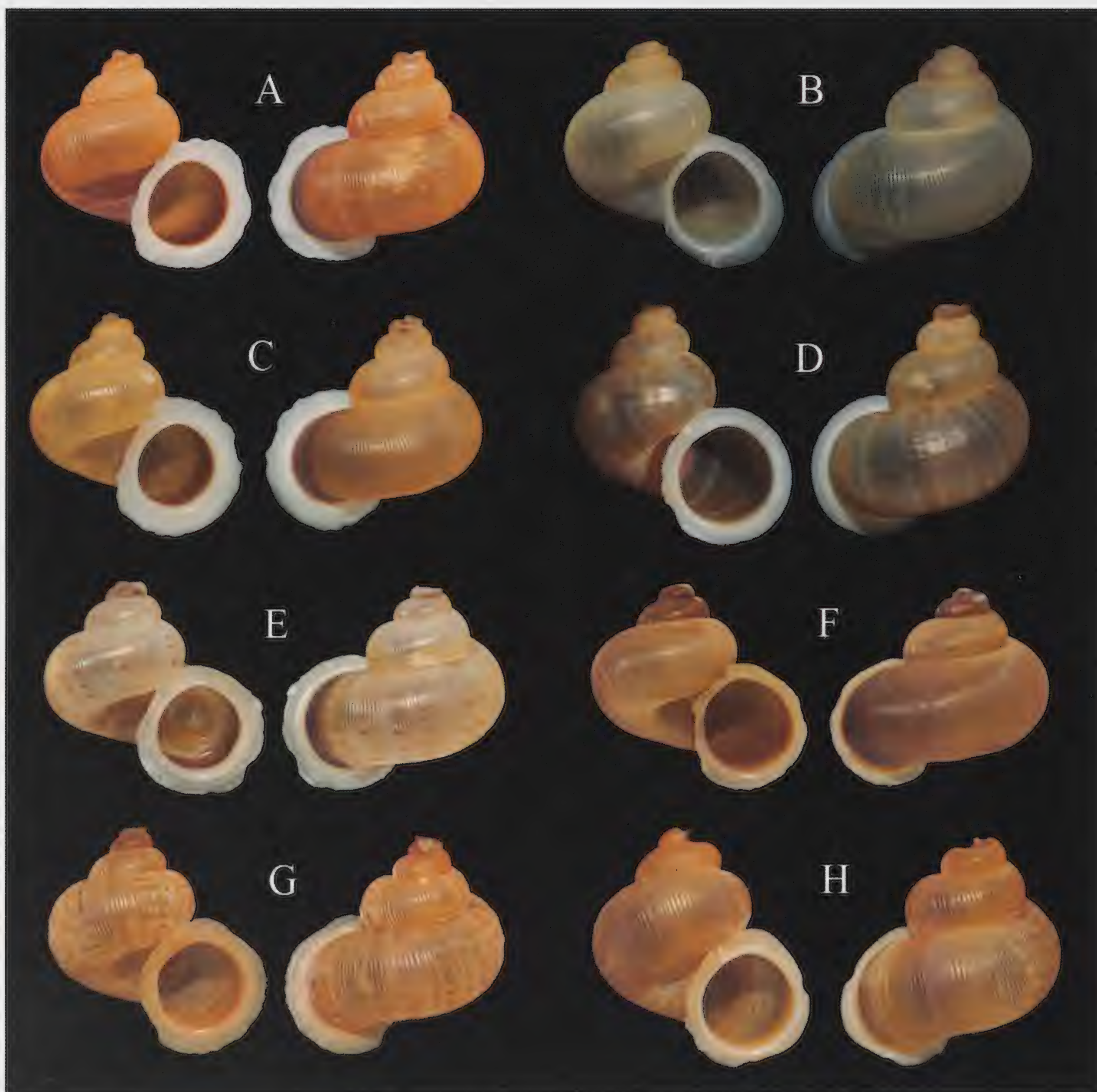


Figure 4. *Chondropometes* species. A = *C. exquisitum* cf. *notatum* (orange morph), NE Sierra de la Güira; B = *C. concolor concolor* E. Pico Chico ; C = *C. exquisitum exquisitum*, Pico Chino; D = *C. eximium malleatum*, La Estrechura in Luis Lazo; E = *C. exquisitum notatum*, Los Portales, W Sierra de la Güira; F = *C. latilabre* (brown morph), W. Pan de Guajabón; G = *C. magnum magnum*, San Carlos; H = *C. magnum signae*, Mogote de Cabezas.

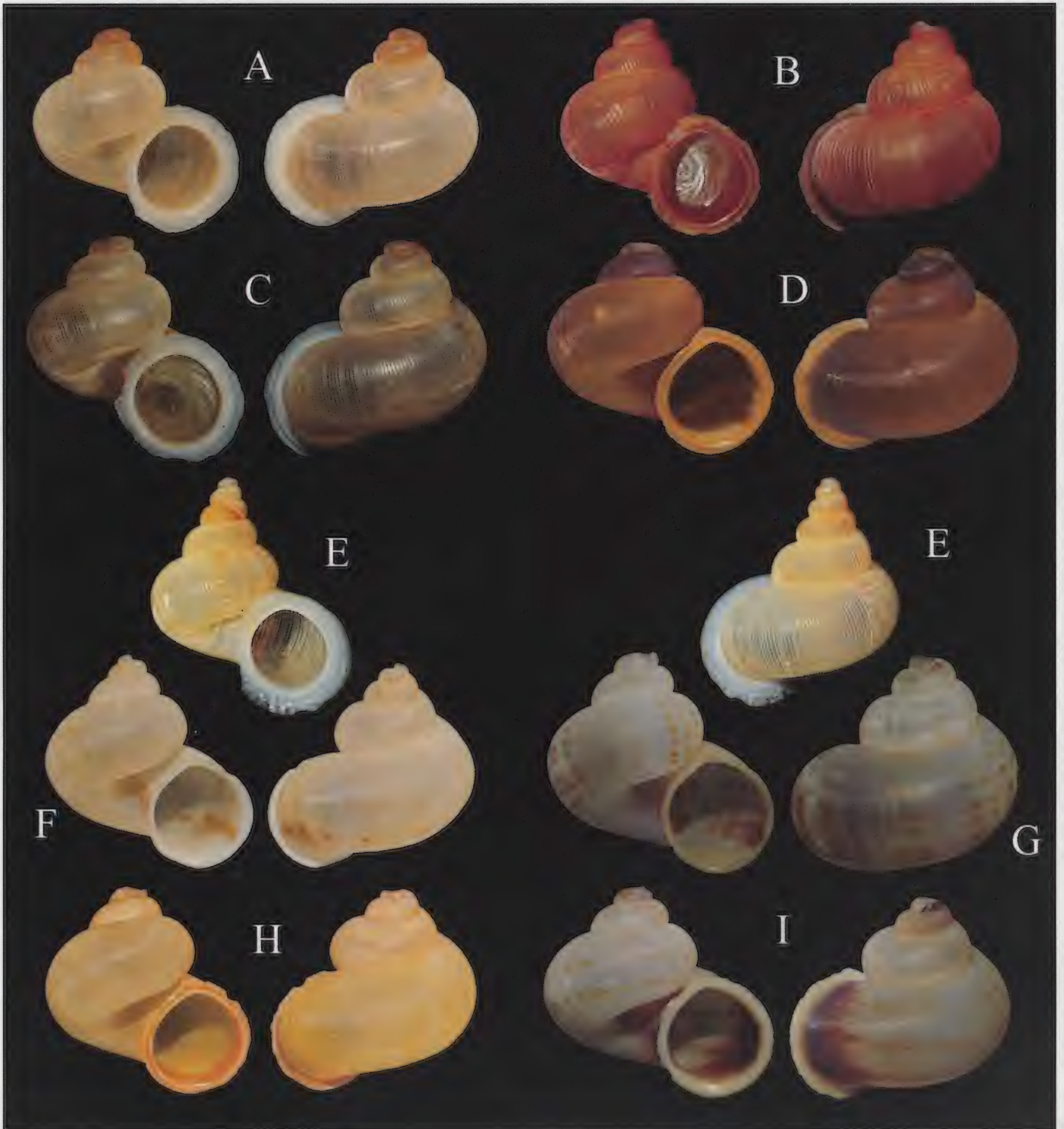


Figure 5. *Chondropometes* species. A = *C. saccharinum saccharinum*, Sierra de Pan de Azúcar; B = *C. sagebieni sagebieni*, Sierra de Guane; C = *C. segregatum segregatum*, Hoyo del Guamá; D = *C. torrei flammilabre*, Pico Grande; E = *C. segregatum sporadicum*, Mogote de Quilla; F = *C. torrei flavidum*, S. Pico Chico; G = *C. torrei gratiosum*, between Pico Chico and Galalón; H = *C. torrei torrei*, Canalete, S. San Andrés; I = *C. torrei cingulatum*, Ensenada de la Ayúa, San Andrés.

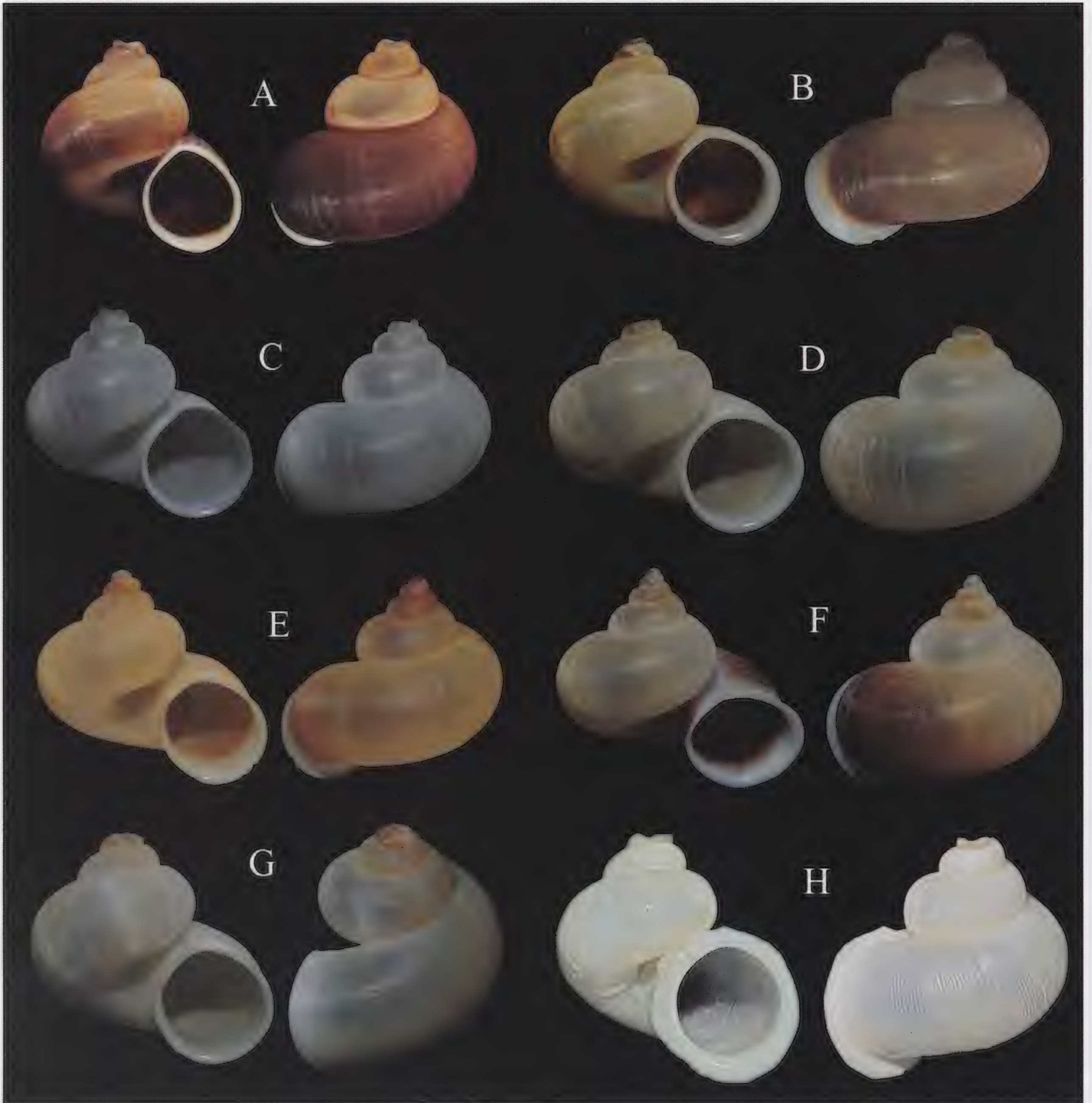


Figure 6. *Chondropometes* species. A = *C. torrei collumelare*, NE Sierra de las Guacamayas; B = *C. vignalense brunneocinctum*, Sierra de Tumbadero (Queque), Viñales; C = *C. vignalense clappi*, N Sierra de la Chorrera, Viñales; D = *C. vignalense jarucense*, Hoyo de Jaruco, Sierra de la Chorrera, Viñales; E = *C. vignalense piadae*, Palmarito, Viñales; F = *C. vignalense poenitensis*, Sierra de la Penitencia, Viñales; G = *C. vignalense puertecitense*, Mogote Puertecitas, Viñales; H = *C. eximium eximium*, Sur de Sa Acostas.

A new species of *Otukaia* (Calliostomatidae) from Alaska

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ABSTRACT A new species of *Otukaia* from the eastern Bering Sea is described from Alaska and is the first member of the genus to be found in the Northeastern Pacific. This species shares many traits with *Otukaia kiheizebisu* (Otuka, 1939) from Japan, which is the type for the genus, but exhibits numerous distinctive characteristics.

KEY WORDS Calliostomatidae, *Otukaia*, Alaska, benthic

INTRODUCTION

Otukaia Ikebe, 1942 are deep cold water species in the family Calliostomatidae, superfamily Trochoidea. Recent taxonomic changes have moved a number of species from the Southern Hemisphere and as far north as Japan into multiple genera other than *Otukaia*. We place this new species in *Otukaia* based on shell morphology, and have submitted tissue samples for DNA analysis. As a contractor working for U.S. National Marine Fisheries Service in Alaska, Roger Clark recognized the first *Otukaia* in samples from the northeastern Pacific in 2002.

SYSTEMATICS

Class Gastropoda

Subclass Vetigastropoda

Order Trochida

Superfamily Trochoidea

Family Calliostomatidae

Genus *Otukaia* Ikebe, 1942

Type species *O. kiheizebisu* (Otuka, 1939)

Otukaia beringensis Tuskes and Clark,
new species
(Figures 1 & 2)

Description. Figures 1 and 2. Height 25 mm, width 26 mm; substance thin. Five post nuclear (PN) whorls; whorls 1-4 angular, lightly convex; PN1 two simple primary cords; PN2-4, two primary keeled cords; low secondary cord on shoulder below suture; suture slightly impressed. Body whorl PN5, secondary cord keeled, minimally projecting on shoulder below suture; two keeled, projecting primary cords above peripheral; third primary cord at periphery, keeled, slightly reduced, interspace nearly smooth; secondary cord below peripheral cord, low broadly rounded and delineates upper base of shell. Base, 25+ finely spaced shallow threads between secondary rounded post-peripheral cord and columella, threads proximal to columella broadly flattened, centrally narrow, distally slightly raised, some incomplete; columella/basal scar dull white; umbilicus closed. Aperture oval 12 × 15 mm, outer lip crenulations associated with primary cords, anterior lip smooth; operculum circular, light brown, ten circular growth scars.



Figure 1. Holotype *Otukaia beringensis*. Apertural view.



Figure 2. Holotype *Otukaia beringensis*. Basal view.

Variation. Three additional specimens have been examined exhibiting the following variation: secondary cord below suture reduced to a low rounded structure; interspace between primary cords with multiple low threads; fine threads at base between secondary cord and

columella may exceed 35; periostracum light brown when present, shell white when absent.

Type Locality. (52° 52' N, 178° 17' W). central Aleutian Islands, Alaska, USA. Depth 1,247 m. Coll. Robert Stone. LACM 3514. Height 25 mm.

Paratypes. 1 mature specimen broken lip, H/W 34 × 34 mm, NOAA/NMFS 94 201201-88. Zemchug Canyon, eastern Bering Sea, Alaska (58°04.27'N, 175°30.48'W), 1,033 m, bottom temperature 2.9°C. Coll. Duane E. Stevens. LACM 3515; 1 mature specimen, broken apex and body whorl. NOAA/NMF 94-2010-01-56 East Bering Sea Slope, 818 m, bottom temperature 3.2°C, on bamboo coral *Isidella* sp. (58°37.92'N, 177°44.53'W), trawled R/V Vesteraalen. SBMNH 619398; 1 mature specimen, height 35.2 mm. NOAA/NMFS. SW of St. Matther Island, Bering Sea, Alaska (58°21.9'N, 177°33.9'W), R/V Morning Star, 23 June 2002, 903 m. Collection of R. Clark.

Diagnosis. Two other species of white Calliostomatidae in the North-eastern Pacific; *Calliostoma* of the subgenus *Akoya* and *Xeniosstoma inexpectans* McLean, 2012. Compared to *Otukaia beringensis*, the *Calliostoma (Akoya) platinum* (Dall, 1890) complex are less bulbous and lack the prominent protruding keeled cords present on all post nuclear whorls of *O. beringensis*, and the outer lip of the aperture is smooth in *C. platinum* but crenulate as in *Otukaia*. *Xeniosstoma inexpectans* has a smooth glossy white shell that lacks threads/cords, and has a smooth aperture.

Otukaia kiheizebisu (Otuka, 1939), from Japan is the type for the genus *Otukaia*, (Figure 3) and the most similar species to *O. beringensis* in the Northern Pacific. The holotype of *O. kiheizebisu* differs from *O. beringensis* as follows: Cords on the body whorl are more

protruding and rounded vs. keeled in *O. beringensis*; anterior lip of *O. kiheizebius* finely crenate caused by the numerous exterior basal threads, anterior lip of *O. beringensis* with few notable crenations associated with larger keeled cords. Additional illustrations of *O. kiheizebisu* have been published by Sasaki (2000), Habe (1965), and Severns, (2011) who illustrated a deep water specimen of *O. kiheizebisu* from Hawaii.



Figure 3. Holotype *Otukaia kiheizebisu*. Apertural view.

Distribution. Currently all specimens are from the Eastern Bering Sea. Specimens collected along the Aleutian Islands suggest they could occur along the chain at suitable depths. It is not known if the Aleutian Basin or the Aleutian trench, which are deeper than the current known locations, impacts their distribution.

Etymology. From the Bering Sea.

Discussion. This is the first species of *Otukaia* to be collected in the North-eastern Pacific. Unlike many other *Otukaia* species, this new species has no beading on the cords. *Otukaia*

kiheizebisu has been taken from Fukushima Prefecture to Tosa Bay, at depths of 200-1000 m Sasaki (2000) in the northern area of Japan, and east to the Hawaiian Islands at a depth of 1200 m Severns (2011). The distribution of *O. kiheizebisu* and *O. beringensis* do not overlap.

Currently, the known depth range of *O. beringensis* is from 818 - 1247 m. Recorded water temperatures at collection sites have been 2.9 to 3.9°C. With additional sampling, both depth and distribution will be better defined. The Holotype was photographed by Robert Stone during his research via an ROV. The animal was feeding on a gorgonian *Calcigorgia beringi* (Nutting) (Robert Stone, personal communication). A paratype was associated with Bamboo coral *Lsidella sp.* which is also a gorgonian.

ACKNOWLEDGEMENTS

We thank Robert Stone for sharing material and information, Ann McGowan Tuskes for manuscript review, Lindsey Groves Natural History Museum of Los Angeles County for access to material and helpful conversations, Daniel Geiger Santa Barbara Museum of Natural History for his suggestions, and the University of Tokyo museum for their public access to the photo of *O. kiheizebisu* holotype.

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New Species of *Cassis* (Cassidae) from the Caloosahatchee Formation of Southern Florida

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ABSTRACT Two new fossil Helmet Shells of the genus *Cassis* Scopoli, 1777, are described from the Early Pleistocene (Gelasian Age) Caloosahatchee Formation of southern Florida. The two new species include *Cassis calusa* n. sp. (restricted to the Fort Denaud Member, early Gelasian Age) and *Cassis powelli* n. sp. (restricted to the Ayers Landing Member, late Gelasian Age) and these are ancestral to both the Calabrian Pleistocene *Cassis schnireli* Petuch, 1994 (Holey Land Member, Bermont Formation) and the living Carolinian Province *Cassis spinella* Clench, 1944. The two new Helmet Shells represent the seventh and eighth species of *Cassis* known from the Florida fossil record.

KEY WORDS *Cassis*, *C. calusa*, *C. powelli*, Cassidae, Caloosahatchee Formation, Fort Denaud Member, Ayers Landing Member, Florida, Pleistocene Epoch, Gelasian Age, Palm Beach County

INTRODUCTION

Helmet Shells of the genus *Cassis* are very rare in the worldwide fossil record, with only around 20 species known to date. The genus has never been very species-rich, with only six living species of *Cassis* (*sensu stricto*) known from the Holocene worldwide tropical seas. An additional seven other smaller cassids in the closely-related subgenus *Hypocassis* are also known from West Africa, the Indian Ocean, and the Australian Region, bringing the total number of living *Cassis* (*sensu lato*) species to thirteen. In Florida, four living species and six fossil species are known, and these include: (living) *Cassis madagascariensis* (Lamarck, 1822), *Cassis tuberosa* (Linnaeus, 1758), and *Cassis flammea* (Linnaeus, 1758) (all wide-ranging Caribbean Province species that extend into southern Florida), and *Cassis spinella* Clench, 1944 (endemic to the Carolinian Province; see Petuch, 2013); and (fossil) *Cassis*

delta Parker, 1948 (Chipola Formation, Burdigalian Miocene), *Cassis flintensis* Mansfield, 1940 (Flint River and Suwannee Formations, Rupelian Oligocene), *Cassis floridensis* Tucker and Wilson, 1932, (Pinecrest Member, Tamiami Formation, Piacenzian Pliocene), *Cassis ketteri* Parodiz and Tripp, 1992 (Fruitville Member, Tamiami Formation, late Piacenzian Pliocene), *Cassis schnireli* Petuch, 1994 (Holey Land Member, Bermont Formation, Calabrian Pleistocene), and *Cassis jameshoubrieki* Petuch, 2004 (Holey Land Member, Bermont Formation, Calabrian Pleistocene; ancestral to *C. tuberosa*) (for the systematics and biogeography of the fossil and living species, see Petuch, 1994, 2004, and 2013; for southern Floridian geology and stratigraphy, see Petuch and Roberts, 2007).

One of the most obvious voids in the molluscan biostratigraphic record of southern Florida was the absence of any *Cassis* species from the early

Pleistocene (Gelasian Age) Caloosahatchee Formation. This fossil-rich formation underlies the entire Everglades region and has been collected extensively over the past four decades, but had never yielded any *Cassis* species. This was always considered to be a problematical situation, as the underlying (directly subjacent) Tamiami Formation contains two described species and the overlying (directly suprajacent) contains an additional two described species. The absence of the genus from the Caloosahatchee Formation was considered to be an artifact of paleoecology and depositional environments, as most of the formation was deposited in very shallow, often intertidal, environments, places where large *Cassis* species would not occur. Finally, in 2011, during extensive canal excavations in the Everglades Agricultural Area of western Palm Beach County, two new species of *Cassis* were discovered in exposed Caloosahatchee beds, one from the lower Fort Denaud Member (early Gelasian Age) and one from the upper Ayers Landing Member (late Gelasian Age). Paleoecological analyses of these Caloosahatchee beds indicated that they represented a deeper water facies, probably around 10 m depth, and contained numerous broken fossil echinoids, the preferred food resource of *Cassis*. These two important additions to the Florida fossil record are described here. The holotypes are deposited in the type collection of the Paleontological Research Foundation, Ithaca, New York (an affiliate of Cornell University), and bear PRI catalog numbers.

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SYSTEMATICS

Class Gastropoda

Subclass Sorbeoconcha

Order Prosobranchia

Infraorder Mesogastropoda

Superfamily Tonnoidea

Family Cassidae

Genus *Cassis* Scopoli, 1777

Cassis calusa Petuch and Berschauer,
new species
(Figure 1A, B)

Description. Shell of typical size for genus, averaging around 145 mm in length, inflated and barrel-shaped, distinctly triangular, with sharply angled shoulder; spire whorls low, subpyramidal, sloping posteriorly; shoulder ornamented with 18-20 small pointed knobs; body whorl sculptured with 16-18 narrow, evenly-spaced prominent cords, with cords being slightly beaded and undulating; fourth cord from posterior end of body whorl larger than others, ornamented with large, low beads; siphonal canal recurved dorsally; parietal shield broken on type lot specimens, presumed to be rounded in shape; aperture proportionally narrow, widening rapidly toward anterior end; inside edge of outer lip ornamented with 10-11 large, narrow, widely-separated teeth, with the central 3 or 4 teeth being wider and bifurcated; columellar area of parietal shield ornamented with 35-45 closely-packed, thin elongated teeth; spire whorls ornamented with numerous closely-packed, thin radiating riblets, becoming larger and more prominent along spire whorl sutures; radiating spire whorl riblets crossed by 3-4 large spiral cords; intersection of radiating riblets and spiral cords producing prominent elongated beads.

Type Material. HOLOTYPE: length 152.8 mm, width 104.7 mm, collected in an excavation along the Miami Canal, 20 m south of Lake

Harbor, Palm Beach County, Florida, PRI 13344; OTHER MATERIAL EXAMINED: length 145 mm, width 90 mm, collected in a road fill excavation at the Okeelanta Sugar Cane farm, 7 km west of the Miami Canal, Palm Beach County, Florida, in the research collection of the senior author; length 144 mm, width 86 mm, from the same locality as the holotype, in the collection of Larry and Judy Haley, West Palm Beach, Florida.

Type Locality. Collected in a de-watered spur canal off the eastern side of the Miami Canal, at the border of the old Talisman Sugar Cane farm and the Holey Land Wildlife Management Area, 20 km south of Lake Harbor, Palm Beach County, Florida. The holotype was found in a depression in the canal wall, at around 6 m below the surface, in the lowest exposed bed of the Caloosahatchee Formation.

Stratigraphic Range. The new species is confined to the Fort Denaud Member of the Caloosahatchee Formation, early Gelasian Age of the Early Pleistocene, and has only been found in the area of the Miami Canal in western Palm Beach County.

Paleoecology. Based on associated fossils, the new cassid preferred sand and coral rubble sea floors in around 10 m depth. Broken echinoid tests and spines were abundant at the type locality, as were the small cassid *Phalium alligator* Petuch, 1994, the olivid *Americoliva erici* (Petuch, 1994), and the conid *Kohniconus susankhane* (Petuch, 1994).

Etymology. Named for the Calusa Indians, the original inhabitants of the southern Everglades and Florida Keys areas.

Discussion. With its distinctly triangular shape, subpyramidal spire, and row of numerous small knobs around the shoulder, *Cassis calusa*

closely resembles the living *C. spinella* Clench, 1944 from the Carolinian Province (North Carolina, the Florida Keys, and the entire Gulf of Mexico), but differs in being a smaller and more elongated shell with a higher spire, and in being a much more ornate shell, with stronger and more pronounced spiral cords on the body whorl and spire. The new species is also ancestral to the younger Bermont Formation *Cassis schnireli* Petuch, 1994 (Calabrian Age of the Middle Pleistocene), but differs in being a much more triangular shell with smaller and more numerous knobs along the shoulder. The larger Bermont species also lacks the strong, narrow, raised spiral cords seen on *C. calusa* and has, instead, two rows of large knobs encircling the body whorl.

Cassis powelli Petuch and Berschauer,
new species
(Figure 1C, D)

Description. Shell of typical size for genus, averaging 150 mm in length, broadly triangular in outline, inflated, barrel-shaped, with high subpyramidal spire; spire whorls sloping; shoulder sharply angled, ornamented with 12-15 small rounded knobs; body whorl ornamented with 12-15 large, wide, evenly-spaced prominent spiral cords; 2 mid-body cords (third and fifth on holotype) being larger and wider than others and being ornamented with 10-12 large knobs; siphonal canal recurved dorsally; parietal shield wide, rounded in outline; aperture proportionally narrow, widening toward anterior end; inside edge of lip ornamented with 11-12 large, narrow teeth, with central 3 or 4 teeth being wider and bifurcated; columellar area of parietal shield ornamented with 35-45 thin, closely-packed elongated teeth; spire whorls ornamented with numerous strong, elongated beads and riblets, arranged in distinct radiating pattern; spire riblets overlaid with 4-5

raised spiral cords, with intersection of cord and riblet producing a distinct elongated bead.

Type Material. HOLOTYPE: Length 108.5 mm, width 74.8 mm, from Ayers Landing exposures in the Griffin Brothers Pit, Holey Land Area, Palm Beach County, Florida, PRI 33143; OTHER MATERIAL EXAMINED: length 190 mm, width 135 mm, same locality and stratigraphic unit as the holotype, in the research collection of the senior author.

Type Locality. The new species was collected in the Griffin Brothers Pit, along the eastern boundary of the Holey Land Wildlife Management Area, approximately 38 km south of South Bay, Palm Beach County, Florida. The holotype was found in a large mass of the Ayers Landing, brought up in a dragline from 7 m depth in the largest flooded pit. Other classic Ayers Landing gastropods were also found along with the holotype, including the turbinellid *Hystrivasum griffini* Petuch, 1994, the cypraeid *Siphocypraea griffini* Petuch, 1991, the olivid *Americoliva jenniferae* (Petuch, 1994), and the sinistral conid *Contraconus heilprini* Petuch, 1994.

Stratigraphic Range. The new species is confined to the Ayers Landing Member of the Caloosahatchee Formation, late Gelasian Age of the Early Pleistocene. To date, *Cassis powelli* has only been collected at the type locality.

Paleoecology. The holotype was found in a fine grained unconsolidated calcarenite that contained abundant sea urchin spines and pieces of broken echinoid tests. Based upon the inclusion of abundant small *Chione* clams within these sediments, the new species probably lived on open sea floors composed of clean carbonate sand near large Turtle Grass (*Thalassia*) beds, in depths of 2-5 m.

Etymology. The new taxon honors Charles L. Powell, II, of San Jose, California, stratigraphic geologist and paleontologist with the United States Geological Survey, in recognition of his many important contributions to the molluscan paleontology of California.

Discussion. Of the known fossil cassids of Florida, *Cassis powelli* is most similar to *C. schnireli* Petuch, 1994 from the Calabrian Pleistocene Bermont Formation, especially in having an inflated, barrel-shaped shell and high spire. The new Caloosahatchee species differs from its younger Bermont descendant, however, in being a more heavily ornamented shell, having numerous large, highly-raised, strong cords on both the body whorl and spire whorls. The knobs on the shoulder and body whorl cords of *C. powelli* are also proportionally larger, more pointed, and more numerous than those on the younger *C. schnireli*. The spire whorls of the Bermont *C. schnireli* are also more domed, with a rounded profile, while the spire whorls of the Caloosahatchee *C. powelli* are more planar and acute.

The discovery of *Cassis calusa* and *Cassis powelli* completes the stratigraphic sequence for the *Cassis spinella*-type Helmet Shell lineage of the Floridian Plio-Pleistocene and Holocene. This evolutionary sequence is as follows (oldest to youngest):

Cassis floridensis (mid-Piacenzian Pliocene) --
Cassis ketteri (late Piacenzian Pliocene) --
Cassis calusa (early Gelasian Pleistocene) --
Cassis powelli (late Gelasian Pleistocene) --
Cassis schnireli (Calabrian Pleistocene) --
Cassis spinella (Ionian and Tarantian Pleistocene and Holocene).

This lineage, which is typified by having very numerous small knobs along the shoulder, is now known to be a separate Helmet Shell evolutionary line that is endemic to Florida and

the Southeastern United States, and is not closely related to the Caribbean *Cassis madagascariensis*.

ACKNOWLEDGMENTS

The authors thank the following individuals: Larry and Judy Haley, who collected the first specimens of *Cassis calusa* along the Miami Canal; Howard ("Andy") Griffin, owner of the Griffin Brothers Pit, who allowed the senior author to conduct field work in his quarries for over 15 years; Brian Schnirel, West Palm Beach, Florida, who assisted the senior author with collecting at several important research sites; Florida Crystals, Inc. Sugar Company, for allowing the senior author to collect on their properties along the Miami Canal.

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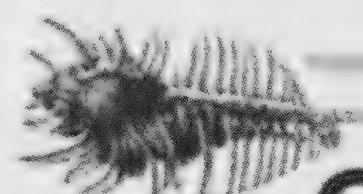
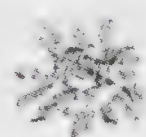
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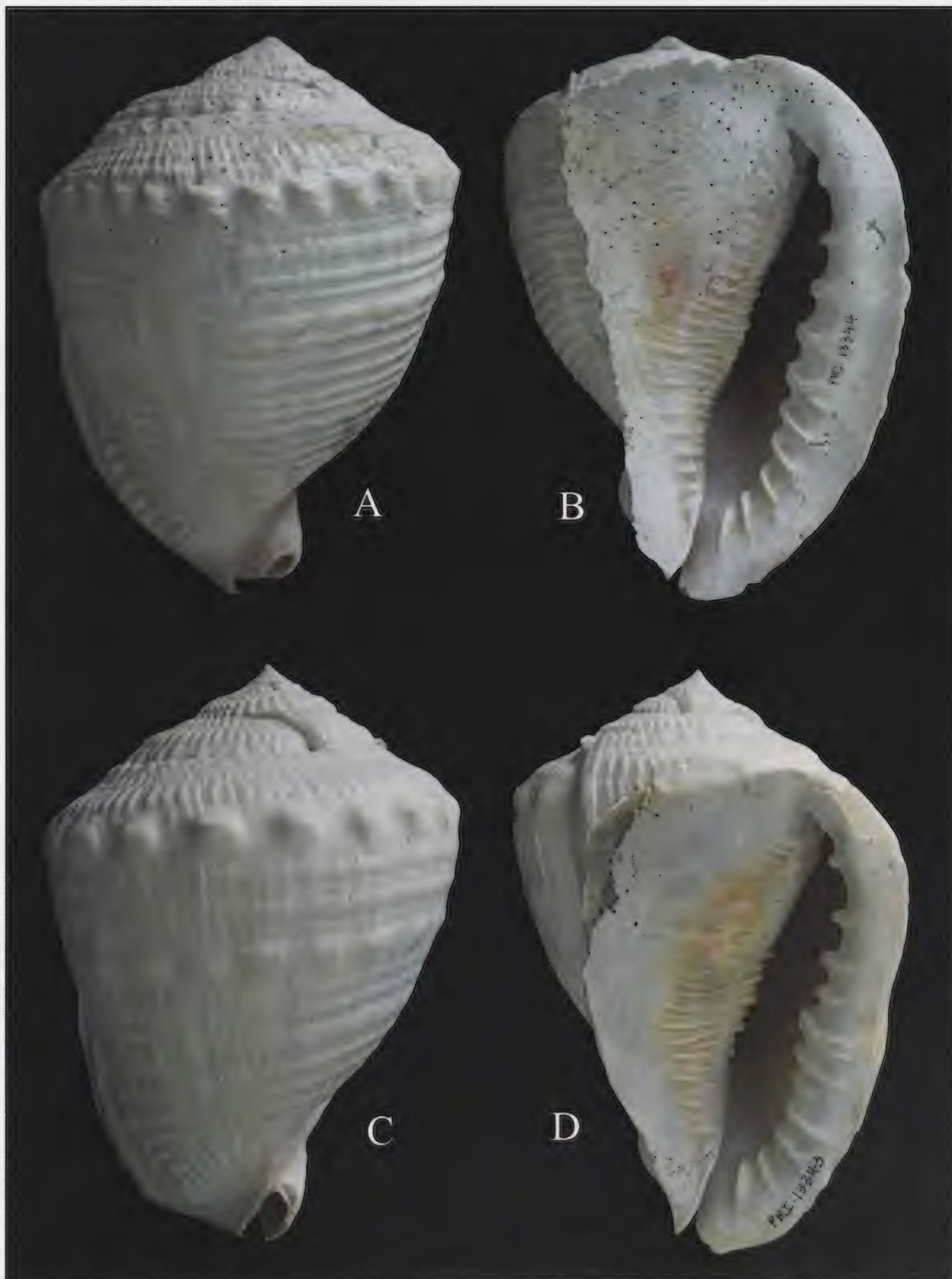


Figure 1. New Species of *Cassis* from the Caloosahatchee Formation of Southern Florida. A, B = *Cassis calusa* Petuch and Berschauer, new species, Holotype, 152.8 mm in length; C, D = *Cassis powelli* Petuch and Berschauer, new species, Holotype, 108.5 mm in length.

Altivasum Hedley, 1914 (Gastropoda: Turbinellidae) from South Western Australia

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ABSTRACT This paper seeks to correct the erroneous taxonomy associated with the current understanding of the *Altivasum flindersi* (Verco, 1914) complex based on type revision, morphological differences and geographic separation. Structurally, there are three distinct species that can be differentiated, *Altivasum flindersi* (Verco, 1914), *A. typicum* Hedley, 1916 and *A. profundum* sp. nov. Geographically, these species are not all sympatric, with *A. typicum* restricted to shallower waters, at depths around 20-180 m off the south Western Australian coast, whereas *A. profundum* is located at the edge of the South Western Australian continental shelf, and *A. flindersi* is found off the coast of the Great Australian Bight at similar depths to *A. typicum*. There is an overlap in distribution between *A. typicum* Hedley, 1916 and *A. flindersi* (Verco, 1914) on the western side of the Great Australian Bight where they are often associated with similar habitats.

KEY WORDS Turbinellidae, *Altivasum*, *A. flindersi*, *A. typicum*, *A. profundum*, South Australia, Western Australia, taxonomy

INTRODUCTION

The subfamily Vasinæ Adams and Adams, 1853, is a worldwide group of marine gastropods, belonging to the family Turbinellidae Swainson, 1835. Within this complex, the monotypic *Altivasum* Hedley, 1914 stands out as a unique large cold water species restricted to the southwestern Australian coast. Many of the marine molluscs that inhabit this region have undergone significant additions to the molluscan fauna (Volutidae: *Amoria weldensis* Bail & Limpus, 2001, *Amoria stricklandi* Bail & Limpus, 2016, *Amoria simoneae* Bail & Limpus, 2003; Cypræidae: *Zoila raywalkeri* Lorenz, 2011). However, the *Altivasum* has not been examined in any significant detail since the revision of Abbott (1959). However, Abbott (1959) overlooked

Hedley (1916) and this has led to long term taxonomic confusion on the status of the *Altivasum* complex (Hinton 1972). This paper argues that the type evidence indicates that *A. flindersi* Verco, 1914 can be divided into two distinct species based on the existing literature, *A. flindersi* Verco, 1914 and *A. typicum* Hedley, 1916. Furthermore, this paper describes one new species that historically has been included within the *A. flinderi* complex. All three *Altivasum* species have a distinctive morphological form, and have distinct ranges, with the range of the new species and *A. flindersi* Verco, 1914 partially overlapped by *A. typicum* Hedley, 1916.

ABBREVIATIONS

AMD: The collection of Aart M. Dekkers,

Purmerend, The Netherlands.

MNHN: Muséum National d'Histoire Naturelle,
Paris, France.

NCB: Naturalis Biodiversity Center, Leiden,
The Netherlands.

JES: The collection of Jason Earle-Sprague,
Melbourne, Australia.

TMC: The collection of Trevor and Marguerite
Young, Cannonvale, Australia.

UWC: The collection of Uwe Weinreich, Cairns,
Australia.

VCC: The collection of Valda Cantemassa,
Proserpine, Australia.

WAM: West Australian Museum, Perth,
Australia.

H: Axial height of shell.

W: Width of shell measured at the shoulder.

SYSTEMATICS

Class Gastropoda

Subclass Caenogastropoda

Order Neogastropoda

Superfamily Turbinelloidea Rafinesque, 1815

Family Turbinellidae Swainson, 1835

(synonym: Vasidae Adams & Adams, 1853)

Subfamily Vasinae Adams & Adams, 1853

Type genus. *Vasum* Röding, 1798.

Diagnosis. Shells in the subfamily are large, heavy, usually prominently sculptured and with two to six irregularly sized columellar plicae on the lower half of the inner parietal wall. The periostracum is thin to heavy. The operculum is horny and somewhat unguiculate in form.

Altivasum Hedley, 1914

Type species. *Latirus aurantiacus* Verco, 1895 (= *Altivasum flindersi* (Verco, 1914) (type by original designation).)

Synonymy.

Altivasum Hedley, 1914, p. 68.

= *Vasum* (*Altivasum*) Hedley – Wenz
1946, p. 1300. Abbott 1950, p. 213.

Abbott 1959, p. 25. Wilson, 1994, p. 60.

Diagnosis. The shell is large, globose and solid. The spire is elevated. The anterior canal is short. The shell has several to many elevated spiral rows with or without long, scale-like spines. The columella has three distinctive plicae. The umbilicus is wide and deep. The periostracum is thin and has a brownish yellow colouration. The operculum is horny and unguiculate, with a terminal nucleus.

Altivasum flindersi (Verco, 1914)
(Figures 1, 2A, 6A)

Type material. Verco (1895), p. 89, pl. 2 fig. 1 (Figure 2A), with the physical specimen believed to be in the South Australian Museum (Abbott 1959).

Type locality. Backstairs Passage, South Australia, at a depth of 20-30 m (Verco 1895, p. 90).

Synonymy.

Latirus aurantiacus Verco, 1895, p. 89, pl. 2,
figs. 1, 1a and 1b.

= *Altivasum aurantiacum* Verco ex
Hedley, 1914, p. 484.

Altivasum flindersi Verco, 1914, p. 69
(replacement name). Hinton 1972, p. 46,
fig. 1a.

Original description. (from juvenile specimen)
“Shell ovate-fusiform, very solid. Spire elevated, shorter than the aperture. Whorls six, without the nucleus which is wanting; rather convex, roundly angled just below the middle, and provided with eight or nine rounded well-marked nodules, about equal in width to the intervals, and costate in the lower half of the whorls. Spiral lira eight to ten, distinct, varying

in size, devious, about equal in width to the interstices, and crossed by longitudinal rather distant scabrous lines of growth. Suture distinctly marginate, sinuous, ascending between the costae, 'edge crinkled by imbricating growth lines. First and second whorls nearly destroyed by fine borings. Last whorl subventricose, shouldered at six lines from the suture, very slightly concave above, convex below, narrowing rapidly to its minimum at the middle point of the ventral surface; with nine very valid longitudinal costae, flatly rounded, rather wider than the interspaces, highest at the shoulder, which abruptly points them, very slightly marked above the shoulder, gradually narrowing and subsiding below, to disappear at the middle of the base. Well-marked spiral lira sub-equidistant (16 in the whorl), with an occasional spiral thread between the more distant (four in the whorl). Above the shoulder the lira, five in number, are narrowest; below it they gradually increase in size anteriorly, rounded, not quite as wide as the interstices. Whole surface roughened by close-set (two to the line) subvertical, imbricating, crinkled, incremental laminae. Suture rather widely margined, sinuous, generally ascending between the costae, conspicuously crinkled by longitudinal laminae. Umbilicus small, partly covered by the inner lip, which is somewhat reflected into it, left margin slightly corrugated by varix of the notch. Columella nearly straight in its lower half; three distinct equal plaits, slightly oblique, the lowest corresponding with the prolongation backwards of the varix of the apertural notch. Aperture obliquely ovate, an inconspicuous narrow ascending posterior sinus formed by the marginate suture. Canal about one-third of the whole aperture, open, wide, slightly deviated to the left, notched anteriorly, very slightly recurved. Outer lip acute, thin, a little everted, due to incipient formation of a costa, crenated by the spiral lira of the whorl, which also form sulcations within; internally of

a deep salmon color at the margin, fading into the polished bluish white throat, and with somewhat darker red lines in the lirite depressions. Inner lip thin, a little spread over the columella, and partially occluding the umbilicus, of a glistening pearly-white color with a rusty tinge, especially between the plaits and near the upper part of the aperture. Ornament, a rusty salmon color most marked near the margin of the aperture, nearly hidden elsewhere by some green adventitious deposit. Operculum ovate, acute, nucleus at anterior apex. Length, 46 mm; greatest breadth, 27 mm; length of aperture, 27 mm; width, 10 mm; of spire, 19-20 mm. The shell most allied appears to be *L. concentricus*, Reeve. My shell is not so thick, the costae and lira are more numerous and not so valid; the last whorl is longer relatively to the spire" (Verco 1895, p. 89, pl. 2, fig. 1)



Figure 1. **A** = *A. flindersi* (Verco, 1914). Thorny Passage, South Australia. H 91.1 mm W 46.8 mm (AMD VAS0178). **B** = *A. flindersi* (Verco, 1914). Port Lincoln, South Australia. Dived 10-20 meter in gravely sand gutters. H 110.3 mm W 57.2 mm (MNHN IM-2014-6965).

Supplementary diagnosis. The shell is of medium size and solid, typically below 130 mm in length. The shell is not spinose on the later whorls. The colour ranges from burnt orange to creamy orange to white. The shell has approximately eight whorls. The early teleoconch bears seven to nine blunt, axial nodules with four spiral lines crossing it and smaller riblets in between. The body whorl has eleven broad axial ribs gradually disappearing anteriorly. Above the shoulder, the axial ribs are crossed by three larger spirals with a smaller spiral in the interspaces. Occurring between the shoulder and the anterior are eleven or twelve strong spiral ribs with smaller ribs in the interspaces. The suture is wavy, bordered below by a scaly fimbriated broad thread. The shell is completely covered with axially aligned small scales, becoming stronger on the more dominant ribs near the anterior. Overall, the shell has a very rough appearance caused by the ribbing and the axially aligned scales. The aperture is ovate, bright white within, and glossy. There is a small shallow posterior canal. The labrum is slightly reflected. The columella bears two small, slightly slanting plicae, with a third plica towards the edge of the siphonal canal. The siphonal canal is narrow and not reflected upwards. The umbilicus is rather large, funnel-shaped and deep. The brown operculum is somewhat obovate, with a nucleus at the anterior point.

Habitat and distribution. Known from the Great Australian Bight, this species can be found within a typical depth range 10-30 m. However, crabbed examples are known down to 180 m. (Ray Walker, personal communication) Examples at hand (AMD) from Port Lincoln were collected in gravelly sand gutters at 10-20 m.

Material and records. Thorny Passage, South Australia, dived in 20-30 m, H 91.1 mm, W 46.8

mm, operculum 24.5 x 12.8 mm, (AMD VAS0178); Thorny Passage, South Australia, dived in 20-30 m, H 97.5 mm, W 51.0 mm, (AMD VAS0177); Port Lincoln, South Australia, dived in 10-20 m in gravelly sand gutters, H 110.3 mm, W 57.2 mm, (MNHM IM-2014-6965); Port Lincoln, South Australia, dived in 10-20 m in gravelly sand gutters, H 103.6 mm, W 56.1 mm, (AMD VAS0046); Off Port Lincoln, Eyre Peninsula, South Australia, upon sand/gravel substrate, amongst seaweeds and algae, 46 m, dived, 2000 (JES).

Remarks. The original description as *Latirus aurantiacus* Verco, 1895 was determined to be a junior homonym of *L. aurantiacus* Montfort, 1810, a Fascolariidae species. Verco (1914) corrected this by erecting *Altivasum flindersi* (Verco, 1914).

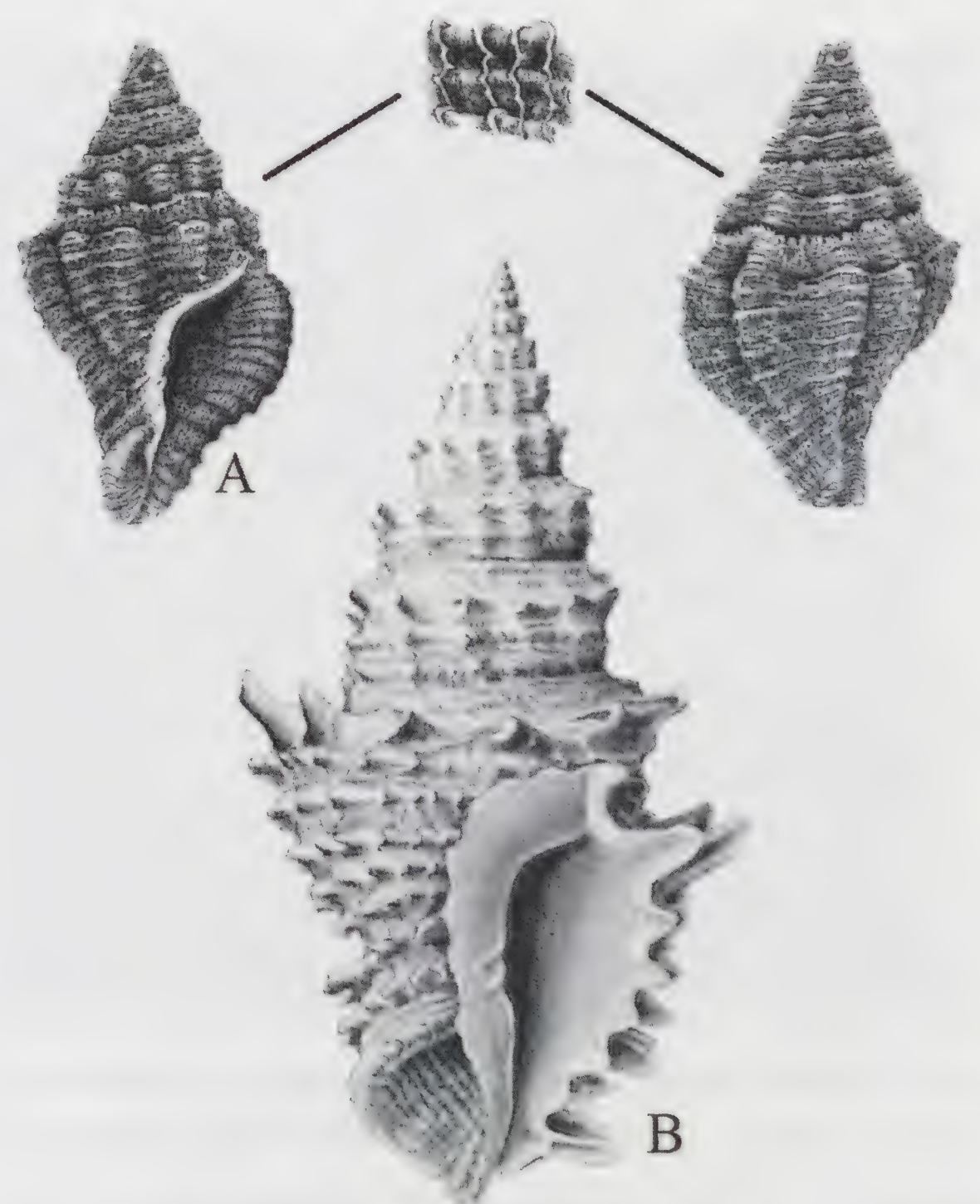


Figure 2. The images of the types of *Altivasum*: A = *Latirus aurantiacus* Verco, 1895 (Verco, 1895, pl. 2, figs. 1, 1a and 1b); B = *A. typicum* Hedley, 1916 (Hedley 1914, pl. 9, fig. 2).

Altivasum flindersi (Verco, 1914) has also been confused with the much larger and coarser spined *A. typicum* Hedley, 1916. *Altivasum flindersi* rarely attains a length greater than 110 mm, and shares a variable colouration with *A. typicum* ranging from bright reddish to creamy orange to white, which is in contrast to the similarly sized *A. profundum* sp. nov., which is known only in white. *Altivasum flindersi* differs further from *A. profundum* by the higher number of spiral ribs and a smaller single interspace rib. Furthermore, *A. flindersi* differs in having a straight siphonal canal unlike the slightly dorso-reflected canal of *A. profundum*.

Altivasum typicum Hedley, 1916
(Figures 2B, 4, 6B)

Type material. Hedley (1916), p. 69 pl. 9, fig. 2 (Figure 2B).

Type locality. Great Australian Bight between Longitude 126° and 129°, 220 m (crabbed).

Synonymy.

Altivasum typicum Hedley, 1916, p. 207.

Altivasum aurantiacum Verco – Hedley 1914, p. 69, pl. 9, fig. 2.

Altivasum flindersi Verco – Hinton 1972, p. 46, fig. 1. Wilson and Gillet 1971, p. 112, pl. 7 fig. 3. Wells and Bryce 1986, p. 114, fig. 436.

Vasum flindersi Verco – Wilson 1994, p. 60, pl. 8, figs. 12a and b.

Original description. “Shell large for its size rather light and thin, ovate-acuminate, broadly and deeply perforate. Colour uniform salmon red. Whorls eleven, graduate, slowly increasing, angles at the suture, contracted at the base then produced to the canal. Apex mucronate, of two smooth whorls. Epidermis thin, membranous and easily shredded. Sculpture: low broad radial ribs ascend the spire obliquely at the rate of

about a dozen to a whorl, but vanish on the last. There are eight spiral cords, the four lower are wider spaced than those above, of which two ascend the spire. Each cord carries distant high vaulted scales, sometimes projecting as long spines, those on the shoulder and the base being most developed, set at the rate of twelve to fifteen to a whorl. Besides, there is an unarmed spiral beneath the suture and another margining the umbilicus. Perforation broad and deep, expanding finally and penetrating as a spiral tube to the earlier whorls, its surface is spirally grooved and transversely scaled. Aperture elliptical, outer lip fimbriated by incipient scales, inner lip spread above on the preceding whorl for a short space, then projecting free for the rest of its course. Above, the aperture is slightly channeled, below it passes into a short narrow and recurved canal. Deep within the aperture, and low on the columella, appear three strong well-spaced plaits, of which the lowest nearly overlies the umbilical margin of the former whorl. Length, 130; breadth 65 mm” (Hedley, 1914, pp. 69 and 70).

Supplementary diagnosis. The solid shell is large, typically ranging in height from 130-190 mm, with rare examples achieving 230 mm in length. The shell is strongly spinose on the later whorls. The colour ranges from orange to pure white. The shell has approximately twelve whorls, the early teleoconch bearing nine to eleven blunt, axial nodules. The later teleoconch developing short anteriorly open knob-like spines which morph gradually into long, slightly recurved, anteriorly open, tubular spines of about 20 mm. The protoconch of one slightly swollen nuclear whorl is round and smooth. Spiral sculpture on post-nuclear whorls consist of five to six raised threads, the most centred one being nodulated. The suture is wavy, indented and bordered directly below by a raised fimbriated thread. Shoulder of the last whorl bears the largest spines, and below this

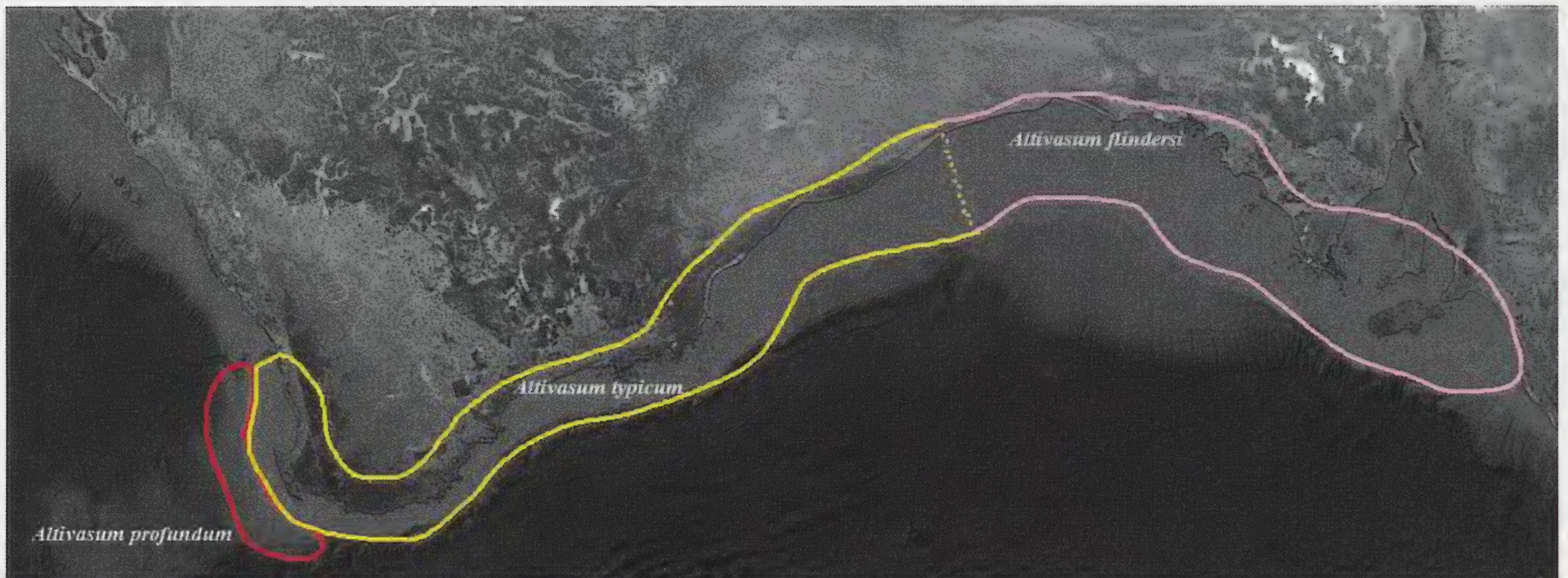


Figure 3. The apparent distribution of *Altivasum* species in southwestern Australia.

row are seven to eight crowded spiral rows of smaller spines. The aperture is ovate and bright white within. The siphonal canal is narrow. The umbilicus is rather large, funnel-shaped and very deep. The periostracum is thin, translucent-brown and coriaceous.

Habitat and distribution. This species is known from southeastern Australia, ranging from Geraldton to the eastern Great Australian Bight and typically in depths of 10-180 m (Figure 3).

Material and records. Fremantle, Western Australia (Wilson 1994); Jurien Bay, Western Australia, L 167.0 mm (Wilson 1994); Off Augusta, Western Australia, Australia, upon coarse sand/rubble/detritus substrate, 40-80 m, craypot, 1989 (JES); Geraldton, 180 m crabbed, 1992 (VCC); Esperance, Western Australia, crabbed, H 222.0 mm (UWC); Unlocalised Great Australian Bight, deep water lobster pots, H 135.0 mm W 75.0 mm (AMD VAS0181); Unlocalised Great Australian Bight, 180 m (VCC); Cape Leeuwin, south-west Australia, crabbed from lobster pots in very deep water, 2015, H 103.0 mm W 52.0 mm (juvenile, AMD VAS0160).

Remarks. Hedley (1916) erected *A. typicum* to replace *Latirus aurantiacus* Verco, 1895, which is described based on a single juvenile specimen of *A. flindersi*. Hedley (1916) provided a full description that clearly articulates a new



Figure 4. *Altivasum typicum* Hedley, 1916, Esperance, Western Australia, crabbed, H 222.0 mm (UWC).

species. Both *Altivasum flindersi* and *A. typicum* have been found together in 30-40 m along the south coast of Australia at Bald Island between

Albany and Esperance. The late Peter Clarkson found both species at Esperance and he thought these different forms represented a case of sexual dimorphism (Ray Walker, personal communication). However, anatomical studies have established that this is not the case and that they are two distinctive species that share a partial range overlap (Ray Walker, personal communication).

Altivasum profundum Dekkers and Maxwell, 2018, new species
(Figures 5, 6C)

Type material. Holotype: Off Augusta, West Australia, ROV – collected at 162 m, H 77.0 mm, W 38.5 mm. see Figure 3. (WAM No. 72381.)

Paratypes:

Paratype 1, H 81.4 mm, W 42.6 mm (WAM No. 72382) Windy Harbour, between 130-150 m;
Paratype 2, H 69.8 mm, W 38. mm (VCC);
Paratype 3, H 70.3 mm, W 37.7 mm (MNHN – IM-2014-6963);
Paratype 4, H 73.5 mm, W 38.5 mm (MNHN – IM-2014-6964);
Paratype 5, H 77.7 mm, W 41.7 mm (NCB no. RMNH.MOL.340751);
Paratype 6, H 52.0 mm, W 27.2 mm (NCB no. RMNH.MOL.340752);
Paratype 7, H 122.5 mm, W 62.0 mm (AMD VAS0129);
Paratype 8, H 112.6 mm, W 58.7 mm (AMD VAS0141);
Paratype 9, H 63.4 mm, W 34.2 mm (AMD VAS0182);
Paratype 10, H 65.3 mm, W 36.9 mm (AMD VAS0183);
Paratype 11, H 68.9 mm, W 36.4 mm (AMD VAS0184);
Paratype 12, H 69.4 mm, W 35.5 mm (AMD VAS0185);
Paratype 13, H 60.4 mm, W 33.7 mm (AMD VAS0186);
Paratype 14, H 64.9 mm, W 34.4 mm (AMD VAS-187);
Paratype 15, H 75.7 mm, W 39.4 mm (AMD VAS0142).

All paratypes from off Windy Harbour, were ROV collected between 130-150 m, crabbed, with exception of paratype 7 from off Augusta ROV collected from 165 m. Paratype 3 was live collected and the operculum is preserved. Paratypes 11-15 have damaged outer lips most likely due to crab attacks. The smaller ones are likely not adult.

Type locality. Off the east coast of Augusta, Western Australia in 180 m of water.



Figure 5. *Altivasum profundum* Dekkers and Maxwell, 2018, new species, off Augusta, West Australia, ROV-collected at 162 m, H. 77.0 mm, W. 38.5 mm, Holotype.

Description. The shell is medium sized and solid, up to 130 mm, not spinose on the later whorls and pure white in colour. The shell has approximately eight whorls. The early whorls bear seven to nine blunt, axial nodules with two spiral lines crossing them. On the body whorl,

the axial nodules extend to at least half the whorl, with six or seven spiral lines crossing them. The suture of the teleoconch is wavy, and is not bordered below by a fimbriated thread. The anterior part of body whorl bearing wide spaced coarse spiral lines.

The fimbriated thread appearing on the last part of the body whorl where some small scales may also occur. The aperture is ovate, bright white within and glossy. There is a small shallow posterior canal. The labrum is slightly reflected. The columella bears three small, spiral and slightly slanting plicae. The siphonal canal is narrow and slightly reflected dorsally. The umbilicus is moderately large, funnel-shaped and deep. The brown operculum is obovate with the nucleus at the anterior point.

Habitat and distribution. *Altivasum profundum* is a deep water species which is known only from the continental shelf at a depth of 130-200 m in southwestern Western Australia (Figure 3). There is no record of *A. profundum* from outside that depth range (Ray Walker pers. com.)

Remarks. *Altivasum profundum* has been historically conjoined with the much larger and coarsely sculptured *A. typicum*. However, the new species seldom attains a length greater than 110 mm, this is in contrast to *A. typicum* in which adults achieve lengths over 130 mm. Morphologically the new species differs from *A. typicum* in the lack of spines on the lower body whorl, and also lacks the scaly, fimbriated thread just under the suture found in that species. The new species is always white, while other species of *Altivasum* have varying colour morphs.

The new species is found consistently around the outside edge of the continental shelf, and therefore, *A. profundum* demonstrates a clear

depth based distinction to *A. typicum*, which is typically found in shallower waters from 20-140 m. Rare examples are known from deeper waters to 180 m (Ray Walker, personal communication). Almost all type material has been ROV collected and these records indicate that there are no morphological intergrades between the two species (Ray Walker, personal communication).

Etymology. The Latin name *profundum* is the second declension nominative meaning abyss or depth. This name was chosen to indicate the habit preference and highlight the difference between the new species and the shallower water dwelling *Altivasum* species.

Discussion. The morphological differences that enable recognition of each *Altivasum* species are in the descriptions, with most important aspects for the differentiation given in a comparative table (Table 1, Figure 6). The restricted geographic range of *A. profundum* nov. sp. to southern Western Australia is also a helpful characteristic that enables differentiation from the similarly sized *A. flindersi* which is restricted to the eastern Great Australian Bight. Thus far the larger iconic *A. typicum*, currently misclassified as *A. flindersi*, has been illustrated the most in literature and is likely the commonest encountered species in private collections, though all three species are scarce.

Altivasum profundum maybe the remnant of the last interglacial maxima population that did not migrate with rising sea levels over the flooded sea terrace (Yokoyama, *et al.* 2001). This is not case for *A. flindersi* and *A. typicum*, both of which colonized the flooded landmass. Furthermore, we predict a fourth species may exist in the deep water to the south of the Great Australian Bight, where a similar plateau exists at depths similar to that which contains *A. profundum*.

Characteristic	<i>A. profundum</i>	<i>A. flindersi</i>	<i>A. typicum</i>
Size	< 130mm	< 130 mm	> 130mm
Subsutural cord	With fimbriations	Smooth	With fimbriations
Colour	Always white	Burnt orange to white	Orange, yellow, white
Spire	7-9 blunt axial nodules with 2 spiral lines crossing them	Axial nodules with 4 spiral lines crossing it and smaller riblets in between	9-11 blunt axial nodules, the later whorls developing short anteriorly open knob like spines that morph gradually into anteriorly open tubular spines of about 20 mm
Suture	Wavy, but not bordered by a fimbriated thread [only on the very last part of the body whorl]	Wavy, bordered below by a scaly fimbriated broad thread	Wavy, indented, bordered below by a raised fimbriated thread which becomes scaly
Dorsal mid-body whorl	Axial nodules extend to at least half the whorl, with 6-7 spiral lines crossing them	Axially aligned scales	Spinose, the largest spines on the shoulder
Anterior dorsal body whorl	Wide spaced coarse spiral lines	Scales get stronger	Strongly spinose on 6-7 spiral rows

Table 1. Comparative table of structural characteristics of *Altivasum* Hedley, 1914.

ACKNOWLEDGEMENTS

Special thanks go out to Ray Walker, Busselton, Western Australia who ROV-collected most of the *A. profundum* type material and donated a number of shells for examination. Furthermore, we also thank Ray for sharing his valuable knowledge on the range finds and anatomical notes on all three species. Thanks go out for everyone who helped us with material for examination and editing, in particular, Anne Butler of Brisbane, Trevor and Marguerite Young of Cannonvale, Uwe Weinreich of Cairns and Valda Cantamessa or Proserpine, and the photos and information supplied by Jason Earle-Sprague of Melbourne.

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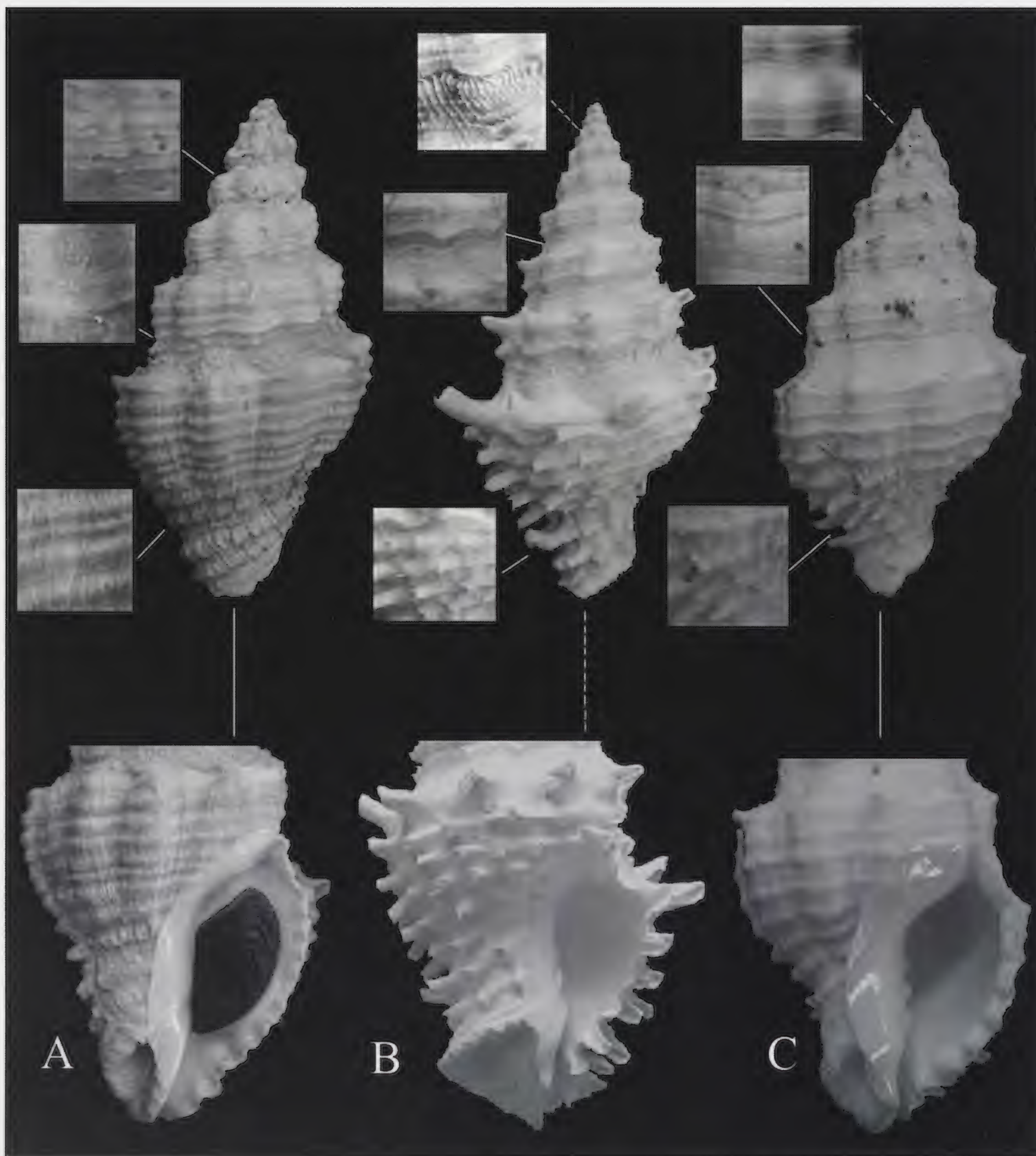


Figure 6. Comparative images of *Altivasum* taxa showing changes in shell morphology as the shell develops: **A** = *A. flindersi* Thorny Passage, South Australia, dived in 20-30 m (MNHN IM-2014-6965); **B** = *A. typicum* Thorny Passage, South Australia, dived in 20-30 m, Esperance, western Australia, dived 30 m, among rocks and sand: (UWC); **C** = *Altivasum profundum* nov.sp. Windy Harbour ROV collected at 136 m. Paratype AMD VAS0141.

The genus *Arctomelon* Dall, 1915 in Alaskan waters, with the description of a new species

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ABSTRACT The Volutid genus *Arctomelon* Dall, 1915 in Alaskan waters is examined, four species are recognized. A new species, *Arctomelon borealis* sp. nov. is described from bathyal depths of the central Aleutian Islands. *A. stearnsii ryosukei* (Habe & Ito, 1965) is recognized as a distinct species.

KEYWORDS Alaska, Biodiversity, *Arctomelon*, Gastropod, Mollusca

INTRODUCTION

The genus *Arctomelon* Dall, 1915 contains three known species (WoRMS, <http://www.marine-species.org/aphia.php?p=taxdetails&id=382314>), two in Alaskan waters, and another from the Gulf of Panama. However, only one species is relatively well known. *Arctomelon stearnsii* (Dall, 1872) is an uncommon northeastern Pacific mollusk, found throughout much of Alaska (Oldroyd, 1927). A subspecies *A. stearnsii ryosukei* (Habe & Ito, 1965) was described from the Bering Sea, and because of its sympatric distribution and similar appearance I had considered it to be only a form of the variable *A. stearnsii*. However, a recent re-examination of images of the type specimens, (Tiba & Kosuge, 1980, and Matsukuma, *et. al.*, 1991) suggest that it may in fact be a distinct species, and is herein recognized as such.

For many years, there were rumors (mostly from crab fishermen) of another species of “Alaskan Volute” with axial ribs occurring in the Aleutian Islands, but nobody seemed to be able to produce one (Rae Baxter personal communication, in 1983). In 1994, while participating in a NOAA/NMFS resource

assessment survey in the Aleutian Islands, I collected two specimens of the ribbed volute. I sent the specimens to Dr. M. G. Harasewych at USNM for identification. He identified them as *Arctomelon tamikoe* Kasuge, 1970. The type was later illustrated by Higo, *et. al.*, 2001).

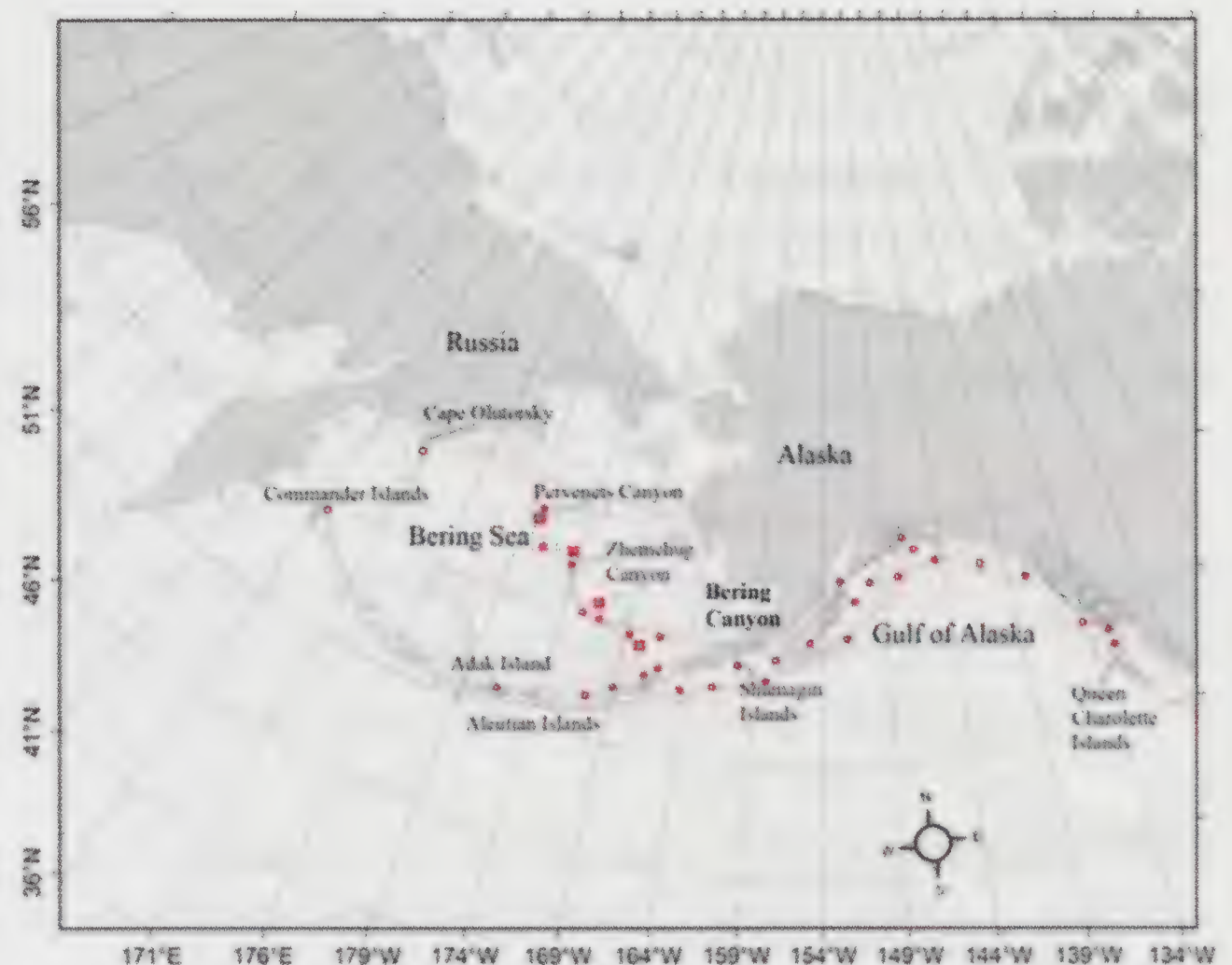


Figure 1. Distribution map of *Arctomelon stearnsii* (Dall, 1872) (•) and *Arctomelon ryosukei* (Habe & Ito, 1965) (■).

Arctomelon tamikoe was said to have come from the South China Sea. However, that is unquestionably an error, as the species is

endemic to the Aleutians. The type specimen seems to be a victim of a “label mix-up”. I have subsequently obtained several additional specimens (most in poor condition) on subsequent Aleutian surveys [1997-2016].

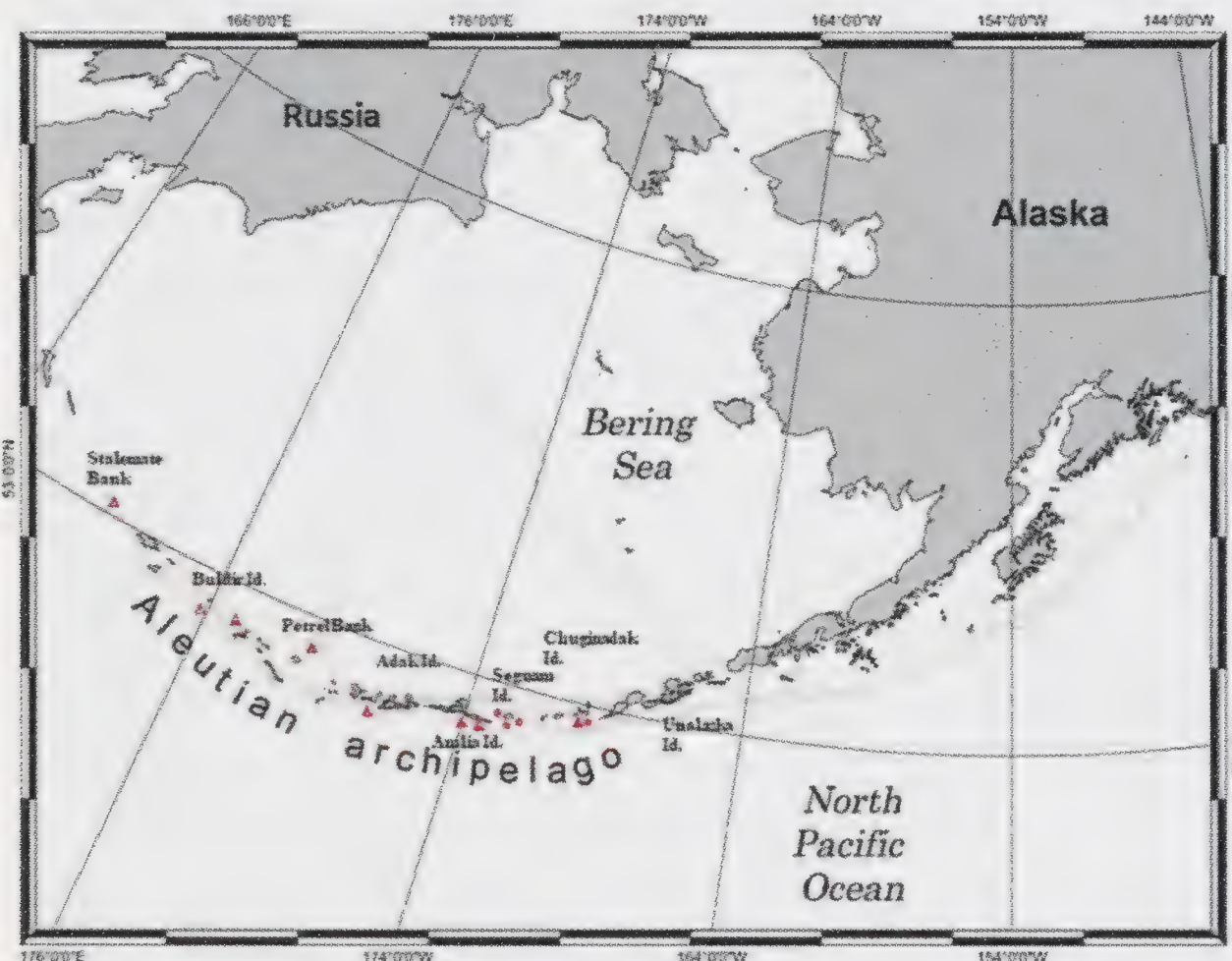


Figure 2. Distribution map of *Arctomelon tamikoe* (Kasuge, 1970) (▲) and *Arctomelon borealis* spec. nov. (●).

Little is known about the biology and natural history of *Arctomelon* spp. In 2010 on a survey in the Bering Sea, I obtained the egg cases of several mollusks, one of these proved to be that of *Arctomelon stearnsii*, the egg case and pre-hatchlings are described and illustrated herein.

A new species, *Arctomelon borealis* restricted to the central Aleutians was discovered on a NMFS survey in 1994, and is herein described and compared to its congeners.

ABBREVIATIONS

ABML, Auke Bay Marine Labs (Juneau, Alaska);

SBMNH, Santa Barbara Museum of Natural History;

LACM, Los Angeles County Museum of Natural History; USNM, United States National Museum (Smithsonian Institution);

NMFS, National Marine Fisheries Service; RNC, Roger N. Clark, Reference Collection; NSMT, National Science Museum, Tokyo; IMT, Imperial Museum, Tokyo.

SYSTEMATICS

Order: Neogastropoda

Superfamily: Muricoidea

Family: Volutidae

Subfamily: Zidoniinae

Genus: *Arctomelon* Dall, 1915

Type species: *Voluta (Scaphella) stearnsii* Dall, 1872 (by original designation)

A. stearnsii (Dall, 1872)

A. ryosukei (Habe & Ito, 1965)

A. tamikoe (Kosuge, 1970)

A. borealis Clark, spec. nov.

Arctomelon stearnsii (Dall, 1872)
(Figures 1, 3A-H, 5I)

Type. USNM 194428

Type locality. Alaska, Aleutian Islands, Shumagin Islands, off Nagai Island (55°00'N, 160°00'W).

Description. Shell large (to 160 mm; largest examined 174 mm, ABML) fusiform, relatively slender, moderately thick, aperture more than half of shell length; exterior surface smooth, but not glossy (chalky in appearance), except for growth lines, suture appressed (pinched), nucleus small; columella with two plicae, columellar callus in very mature specimens; color blue-gray exteriorly, interior purple-gray to reddish-brown.

Radula (Figure 5I): Rachiglossate (Abbott, 1968); bearing a single tricuspid tooth; central cusp about 1/3 longer than outer cusps; the dorsal side of the central cusp bears a depression into which the tip of the overlying

tooth lies, lateral cusps shorter, broadly separated from the central cusp.

Egg capsules (Figure 4E): blister-like 23 mm x 9 mm, granular, dark yellow-orange in color, bearing three embryos (Figures 4F & G), measuring 9-11 x 5.2 mm, pale pinkish white in color.

Columellar plicae well developed; protoconch dome-like.

Distribution. Wide spread in the North Pacific, found throughout much of the Bering Sea From Cape Olutorsky, Russia (59°18.2 N, 170°18.7 E) to (Pervenets Sea Canyon) (60°N), along much of the Aleutian Islands chain, west to at least Adak Island (177°W), near the Commander Islands, Russia (167°E) and throughout the Gulf of Alaska and Prince William Sound (to about 60 N), east and south to the Haida Gwaii (Queen Charlotte Islands) in northern British Columbia (54°N, 132°30 W).

Habitat. Found on muddy, sandy and cobbly bottoms, at depths of 15-1065 m, with bottom temperatures of 2.3-5.0°C.

Remarks. The holotype is in very poor condition, collected from a Codfish stomach, it is badly eroded and discolored, but is easily recognizable. Variable in form, some specimens are very short spired, others tall spired, whorls may be slender or inflated.

At Adak Island in the Aleutians, a dwarf population of *A. stearnsii* rarely exceeding 10 cm in length occurs in shallow water (< 15 m), amongst cobbles and in beds of the horse mussel *Modiolus modiolus* (Figure 4 A). Figure 3 F represents an unusual, highly compressed specimen (similar in form to *A. borealis*) taken at 732 m in the Gulf of Alaska, east of the Shumagin Islands. This appears to be only a

variant of *A. stearnsii*, but more material is needed to determine if it may be distinct.

Arctomelon ryosukei (Habe & Ito, 1965)
(Figures 1, 4I-L)

Type. National Science Museum, Tokyo.

Type locality. Bering Sea.

Description. Shell large, to 136 mm (holotype), solid, fusiform, whorls broad, rounded, inflated, aperture more than half of shell height; suture impressed (not appressed as in *S. stearnsii*), nucleus relatively large (4.2-6.6 mm); exterior chalky, blue-gray, interior purple-brown.

Radula type is unknown. At the time of this writing, the radula of *Arctomelon ryosukei* was not available for study.

Distribution. *Arctomelon ryosukei* has a very limited, sympatric distribution with its congener *A. stearnsii*, along the shelf break of the eastern Bering Sea continental shelf, Pervenets Canyon (59°40N, 178°26 W) to Bering Canyon (54°57.24 N, 167°10 W), at depth of 206-312 m.

Habitat. Mud bottoms with a bottom temperature of 2.3°-3.5°C.

Remarks. Described as a subspecies of *A. stearnsii*, but the sympatric distribution belies that designation, and it is herein recognized as a distinct species. *A. ryosukei* may be distinguished from inflated specimens of *A. stearnsii* by the impressed suture (Figure 4L), as opposed to the appressed suture of the latter (Figure 4H).

Arctomelom tamikoe Kasuge, 1970
(Figures 2, 5A-D, J)

Type. Imperial Museum, Tokyo #80-21 (Figure 5A)

Type Locality. Originally reported as “South China Sea” - in error; Alaska, central Aleutian Islands, here designated as the Petrel Bank, NE of Semisopochnoi Island (52°15 N, 179°W).

Description. Shell large to 200 mm; (largest examined 208 mm, David Stanchfield collection) solid, fusiform. Nuclear whorls bulbous, smooth, often eroded; aperture about one half of shell height; shoulders rounded, sutures impressed; exterior chalky, blue-gray with 27-34 (14 in young specimens < 40 mm) close-set, rounded axial ribs, most prominent on the upper half of the whorls; interior glossy, purple-brown; columnella with two prominent folds; canal short and broad. Animal cream, with light orange mottlings; eyes black.

Radula (Figure 5J): bears a single, broad, tricuspid tooth. Base of tooth crescentic, central cusp broad, triangular, bearing a well-marked depression on the dorsal side where the tip of the overlapping tooth lays, when the teeth are laid flat. The lateral cusps are broad at the base, tapering to a sharp tip, about half as long, and half as wide as the central one, rounded on the lateral margin, and separated from the central cusp by a broad notch.

Distribution. Endemic to the, central and western Aleutian Islands, from south of Yunaska Id. (170°16.06 N, 170°35.7 W) (143-2010-1-31) to Stalemate Bank, west of Attu Island (53°15.14 N, 170°51.68 E) (147-2004-1-226).

Habitat. Rocky, gravelly and coral (hydrocoral) rubble bottoms, at depths of 154-457 m, with a temperature of 3.8-4.3°C, most frequently 4.0°C.

Natural History. Like *Arctomelon stearnsii*, *A. tamikoe* is a predator/scavenger and is sometimes taken in king crab pots (David Stanchfield, personal communication, May 2016).

Remarks. *Arctomelon tamikoe* closely resembles its Alaskan sibling *A. stearnsii*, but is easily distinguished by: (1) the presence axial ribs, (2) impressed, not appressed, “pinched” suture, and (3) larger, nuclear whorls. *A. tamikoe* is a very rare species, in more than 3,000 trawl samples taken in the Aleutian Islands since 1994 fewer than twenty examples have been recovered. Very large specimens frequently have up to 2.5 cm of their apices truncated (worn off, flat) by erosion.

Arctomelon borealis Clark, new species
(Figures 5 E-H, K)

Type material. Holotype, SBMNH 167094 (Figures 5E-F), 82.4 mm; Paratype 1, LACM 3649, 67.8 mm. South of Seguam Island (52°04.99 N, 172°26.34 W), 162 m (NMFS 94-199401-61); Paratype 2, ANSP A476689, 126.0 mm. Seguam Pass (51°58.35 N, 172°36.86 W), 167m (NMFS 94-200201-192); Paratype 3, RNC 4992, 85.1 mm. Seguam Pass (52°04.04 N, 172°33.66 W), 144 m (NMFS 176-201601-45).

Type locality. Alaska, Aleutian Islands South of Chuginadak Island (52°42.08 N, 169°49.78W), 148 m (*leg.* William C. Flerx, 22 May, 1996).

Description. Small for genus, rarely exceeding 90 mm (largest examined 126 mm, Paratype 2) solid, fusiform, aperture more than 2/3 of shell height, suture appressed, but not excessively as

in *A. stearnsii*; nucleus large bulbus, somewhat larger than that of *A. stearnsii*, diameter 5.0-6.2 mm compared with 3.6 mm to 4.8 (rarely 5.0) mm; columella with two plicae; color light gray-brown exteriorly, interiorly brown or purple-brown, overglazed with gray in mature specimens.

Radula (Figure 5K). Typical for genus, with a single tricuspid tooth; tooth similar to that of *A. stearnsii*, but cusps sub-equal in length, central cusp only scarcely longer the lateral cusps, moderately broad; differs from both *A. stearnsii* and *A. tamikoe* in lacking the small depression on the dorsal surface of the central cusp, where tip of the overlying tooth lies.

Distribution. Endemic to the central Aleutian Islands, between Segum and Samalga Passes (169° W-173° W).

Habitat. Black (volcanic) sand at depths of 144-167 m, with bottom temperatures of 4.2-4.8°C.

Remarks. *Arctomelon borealis* may be distinguished from its congeners by: (1) its brown shell, as opposed to the blue-gray shells of its congeners, and (2) the proportionally large nuclear whorls.

ACKNOWLEDGEMENTS

Robert Lauth, Alaska Fisheries Sciences Center, for generating maps and providing NMFS survey data; Dr. James Orr, Alaska Fisheries Science Center, for continuing to secure mollusk specimens from NMFS surveys; Lindsey Groves (NHMLAC). To Dr. Daniel Geiger of the Santa Barbara Museum of Natural History for taking the SEM micrographs, Dr. Chong Chen, JAMSTEC, Yokohama, Dr. Jerry Harasewych (Smithsonian Institution), for identifying *Arctomelon tamikoe*, Paul

Callomon, Academy of Natural Sciences, for providing an image of the type specimen of *Arctomelon tamikoe*, and to David Stanchfield, La Quinta, California, for making his personal collection available for study. The comments of anonymous reviewers were invaluable.

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Figure 3 A-H *Arctomelon stearnsii*.

A = Holotype, USNM 194428; **B** = RNC 4935, 145.3 mm, SE of Shumagin Is. (*leg.* RNC, 6 June, 2009) (NMFS 159-200901-76); **C** = RNC 4936, 92.4 mm, SW of Montague Island (*leg.* RNC, 12 July, 2009) (NMFS 94-200901-226); **D** = RNC 4566, 155 mm, N of Umnak Island, 91 m (*leg.* William C. Flerx, 9 June, 1994) (NMFS 94-199401-30); **E** = RNC 4717, 133 mm, Icy Strait, 25 m (*leg.* Lou Barr, circ. 1980's); **F** = RNC 4887, 113.8 mm, Gulf of Alaska, 732 m (*leg.* RNC, 13 June, 2005) (NMFS 134-200501-85); **G** = RNC 4551, 89 mm, W of Ketchikan, 120 m (Carmelita Zwick, November, 1990); **H** = RNC 4965, 84 mm, Bering Sea, 1,065 m (*leg.* RNC, 6 July, 2010) (NMFS 94-201001-143).

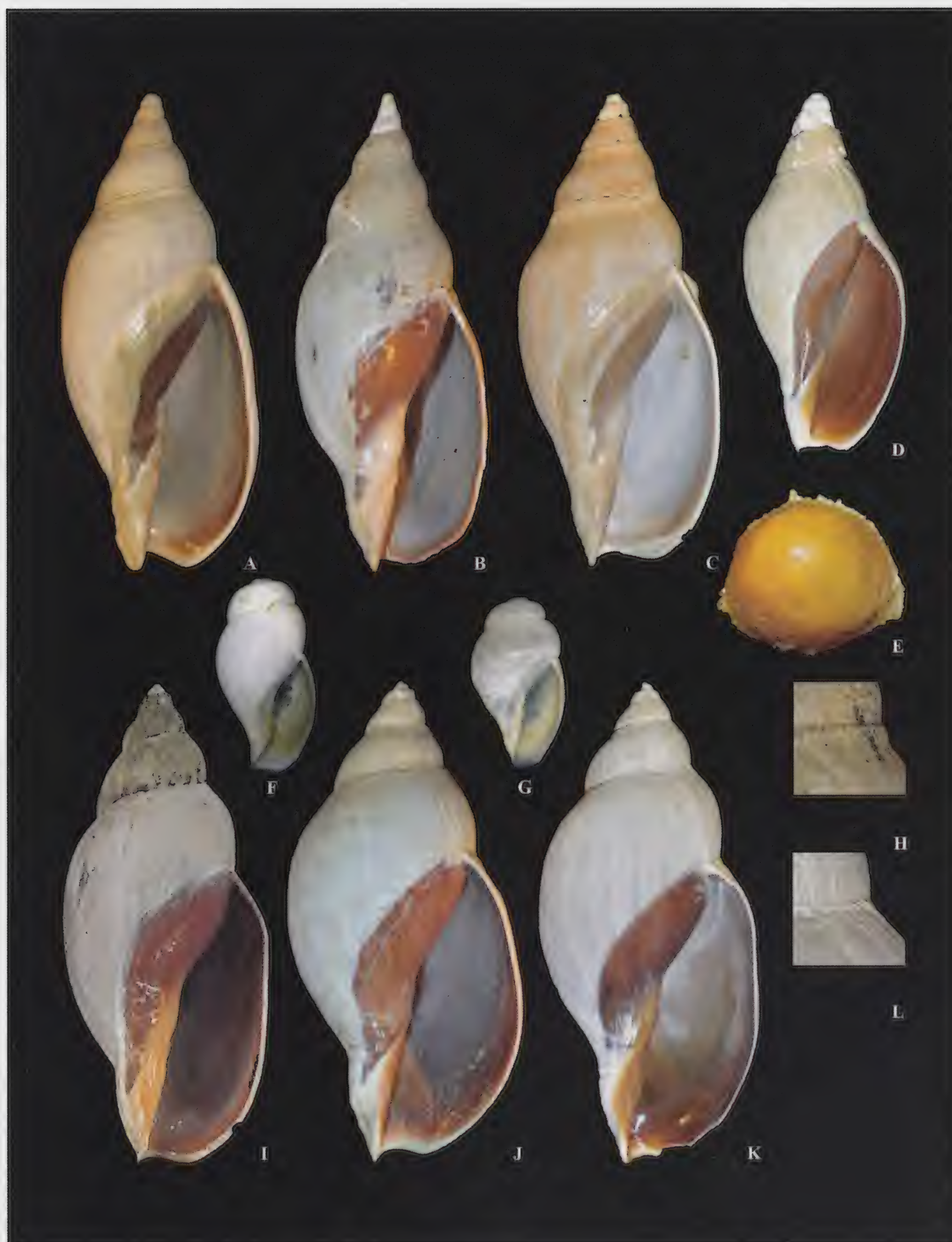


Figure 4 A-H *Arctomelon stearnsii*. I-L *Arctomelon ryosukei*.

A = RNC 5049, 95.0 mm, Adak Island, 15 m (*leg.* Stephen C. Jewett, 19 July, 2011); **B** = RNC 4966, 115.1 mm, Bering Sea, 236 m (*leg.* RNC, 22 June, 2010) (NMFS 94-201001-87); **C** = RNC 4501, 93.5 mm, Mitkof Island, shore (dead) (*leg.* RNC, August, 1983); **D** = RNC 4613, 38.6 mm, Gulf of Alaska, 209 m (*leg.* RNC, 9 June, 1999) (23-199901-109); **E** = RNC 4902, Egg capsule, 23 mm x 9 mm, NE of Unalaska Island, 425 m (*leg.* RNC 18 July, 2010) (NMFS 94-201001-203); **F** = RNC 4902, juv., 11 mm, NE of Unalaska Island, 425 m (*leg.* RNC 18 July, 2010) (NMFS 94-201001-203); **G** = RNC 4902, 9 mm, NE of Unalaska Island, 425 m (*leg.* RNC 18 July, 2010) (NMFS 94-201001-203); **H** = close-up of appressed suture; **I** = Paratype, Kawamura coll., NSMT # ? (after Matsukuma, *et. al.*, World Shells of Rarity and Beauty); **J** = RNC 4903, 100.7 mm, Bering Sea, 206 m (*leg.* RNC, 6 June, 2010) (NMFS 94-201001-13); **K** = RNC 4906, 110.5 mm, Bering Sea, 312 m (*leg.* RNC 11 June, 2010) (NMFS 94-201001-40); **L** = close-up of impressed suture.



Figure 5 A-D, J *Arctomelon tamikoae*. E-H, K *A. borealis*, I *Arctomelon stearnsii*.

A = Holotype, IMT 80-21, 130.4 mm, Aleutian Is. (Petrel Bank); **B** = RNC 4744, 168 mm, SW of Buldir Island, 194 m (*leg.* 18 July, 2016) (NMFS148-201201-169); **C & D** = RNC 4612, 39.4 mm & 126.8 mm (*leg.* RNC, 7 July, 2002) (NMFS 94-200201-157); **J** = Radula (NMFS 143-2010-60); **E & F** = Holotype, SBMNH 167094, 82.4 mm; **G** = Paratype 1, LACM 3649, 67.8 mm (*leg.* Theresa Turk, 15 June, 1994) (NMFS 94-199401-61); **H** = Paratype 2, ANSP A476689, 126 mm (*leg.* RNC, 18 July, 2002) (NMFS 94-200201-192); **I** = Radula (NMFS 94-201001-60); **K** = Radula, Paratype 3, RNC 4992 (176-201601-45).

***Leptopoma melanostoma janetabbasae*, a new subspecies (Gastropoda: Cyclophoridae) from Indonesia, and Correction of Errata in “New Shells of South Asia”**

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ABSTRACT A new subspecies of genus *Leptopoma* Pfeiffer, 1847 is described from Selawati Island, West New Guinea, Indonesia and compared to six other species and forms of this genus: *Leptopoma melanostoma* (Petit, 1841), *Leptopoma niasense* Fulton, 1907, *Leptopoma perlucidum* f. *subalatum* Quadras & Möllendorff, 1893, *Leptopoma helicoides* (Grateloup 1840), *Leptopoma vitreum* (Lesson, 1830) and *Leptopoma stainforthi* (Sowerby, 1842). It is characterized by a translucent shell, dark brown umbilicus, black outer lip and columella, narrow but raised peripheral rib, and wide dark brown umbilicus.

KEY WORDS Gastropoda, Cyclophoroidea, Cyclophoridae, *Leptopoma*, Selawati Island, West New Guinea, Indonesia, new taxon

INTRODUCTION

The genus *Leptopoma* Pfeiffer, 1847 belongs to the family Cyclophoridae and has many species collected in Indonesia. In July of 2018, a hitherto cyclophorid was found. It was not listed in the works by Parkinson, Hemmen & Groh (1987), Abbott (1989), Maassen (1997), Dharma (2005), Stanisic, Shea, Potter & Griffiths (2010), Tarruella & Domènech (2013) and Thach (2016, 2017, 2018). It is here described as new to science.

Abbreviations.

BOR/MOL	Borneensis Malacology Collection, University of Malaysia Sabah
LKCNHM	Lee Kong Chian Natural History Museum, National University of Singapore
RMNH	Naturalis Center of Biodiversity, Leiden, The Netherlands
NNT	Collection Dr. Thach
JAC	Collection John Abbas
AH	Aperture height

AW	Aperture width
SH	Shell height
SW	Shell width

SYSTEMATICS

Class Gastropoda Cuvier, 1797
 Superfamily Cyclophoroidea Gray, 1847
 Family Cyclophoridae Gray, 1847
 Genus *Leptopoma* Pfeiffer, 1847
 Type species: *Cyclostoma vitrea* Lesson, 1830

Leptopoma melanostoma janetabbasae
 Thach, 2018 (Figures 1-5)

Description. Shell conic-heliciform, translucent, medium-sized for the genus (12.4-15.2 mm in height) and slightly higher than wide with shell width 92.4% of shell height (see Table 1 with measurements on eight specimens). Spire conical and tall, sutures deep. Body whorl swollen, periphery rounded with a narrow, raised spiral rib. Sculpture consist of narrow, slightly raised, widely-spaced spiral ribs with finer and more closely-spaced spiral riblets in

interspaces. Axial sculpture with oblique and widely-spaced axial ribs, crossing spiral ribs and riblets. Aperture circular, wide, slightly deviated to ventral surface of body whorl and covering a large part of shell surface with width 66.9% of shell width and height 60.5% of shell height (see Table 1). Outer lip double, broad, calloused and slightly reflected. Umbilicus large and deep, columella straight. Operculum corneous, thin, translucent, slightly concave and multispiral with a central nucleus. Color translucent white with dark brown umbilicus, yellow brown operculum, black outer lip and columella.

Diagnosis. The new subspecies is readily recognized by translucent shell, dark brown umbilicus, black outer lip and columella and a narrow but raised peripheral rib at mid body whorl.

Type material.

HOLOTYPE 15.2 mm in height at LKCNHM with Registration No: ZRC.MOL.13431 (Figures 1 & 2).

Other Material Examined. Paratypes: all from type locality, Paratype 1: 14.1 mm in height at BOR/MOL Registration No: BOR/MOL 13978

(Figure 5); Paratype 2: 12.4 mm (Figure 3) and Paratype 3, 13.6 mm (Figure 4) NNT; Paratype 4, 14.6 mm high and Paratype 5, 14.3 mm (not illustrated) NNT; Paratype 6, 15.0 mm (not illustrated) JAC and Paratype 7, 13.4 mm (not illustrated) JAC.

Type Locality. Selawati Island, off West New Guinea of Indonesia.

Habitat. The type specimens were collected on low vegetation (bushes) or among leaf litter.

Etymology. This new subspecies is named after Janet Abbas from Indonesia for her help in collecting the type material.

Discussion. The new subspecies differs mainly from *Leptopoma melanostoma* (Petit, 1841) (Figure 5, bottom) in many of the characteristics: shape is more swollen, umbilicus is brown (not white); spiral ribs are much stronger, well visible without magnifying glass (not smooth when seen by the naked eye as described in original description at page 308 of “Travaux inédits”) and white (not reddish as described in page 309 of original description), outer lip is black with purple inner margin (not maroon black as described in original description) and

No	SH Mm	SW mm	SW/ SH	Mean SW/SH	AH mm	AH/ SH	Mean AH/SH	AW mm	AW/ SW	Mean AW/SW
1	15.2	13.7	0.90	0.92	8.5	0.56	0.61	8.8	0.64	0.67
2	14.1	12.3	0.87		8.8	0.62		8.5	0.69	
3	12.4	12.1	0.98		7.7	0.62		7.7	0.64	
4	13.6	13.0	0.96		8.2	0.60		8.3	0.64	
5	14.6	14.0	0.96		8.7	0.60		9.3	0.66	
6	14.3	13.1	0.92		9.2	0.64		8.9	0.68	
7	15.0	13.0	0.87		9.0	0.60		9.2	0.71	
8	13.4	12.4	0.93		8.0	0.60		8.5	0.69	

Table 1. Mean SW/SH, AH/SH and AW/SW of *Leptopoma melanostoma janetabbasae* n.ssp.

the new subspecies is found on a different island; *i.e.* they are not sympatric.

Leptopoma melanostoma janetabbasae n. ssp. is close to *Leptopoma niasense* Fulton, 1907 (Figure 6) but differs mainly in more swollen body whorl, black outer lip and columella. *Leptopoma perlucidum* f. *subalatum* Quadras & Möllendorff, 1893 (Figure 7) differs mainly from the new subspecies in white outer lip and columella, not brown umbilicus, aperture with external pattern visible within and not slightly deviated to ventral surface of body whorl. *Leptopoma helicoides* (Grateloup 1840) (Figure 8) is distinguished mainly from the new subspecies by a less translucent shell, more conspicuous peripheral rib, much stronger spiral sculpture, and lacking the black outer lip and columella. *Leptopoma vitreum* (Lesson 1830) (Figure 10) differs mainly from the new subspecies in longer axial ribs, lacking the black outer lip and columella, and the aperture is not slightly deviated to ventral surface of body whorl. *Leptopoma stainforthi* (Sowerby, 1842) (Figure 11) differs mainly from the new subspecies in smaller adult size, more angulate periphery, less wide umbilicus, and lacking the black outer lip and columella.

ERRATA - New Shells of South Asia (2018)

Vietnam is rather rich in land snails of the genus *Amphidromus* Albers, 1850 that live mostly in South and Central Vietnam. About 72 species and subspecies of this genus were described in Vietnam, mostly since 2015. At the beginning of 2018, two specimens of *Amphidromus inversus inversus* (Müller, 1774) were discovered in Phú Quốc Island at Southwest of Vietnam. In the book "New Shells of South Asia" published by the author in 2018, it is cited at pages 54 and 173, illustrated at plate 50 and back cover of the book. The name *Amphidromus anhi* Thach, 2018 at page 173 is

to be replaced by *Amphidromus inversus inversus* Müller, 1774 (see Figures 9 & 12 herein).

The species name *Amphidromus beschaueri* Thach, 2018, described therein and mentioned on pages 47, 137, 138, 173 of this book is to be replaced by *Amphidromus berschaueri*, due to a clerical error.

The name *Amphidromus poi* at pages 149, 150 is to be replaced by *Amphidromus koonpoi*.

ACKNOWLEDGEMENTS

I want to thank the Naturalis Center of Biodiversity, Leiden, The Netherlands for the photo of *Leptopoma melanostoma*, to G.& Ph. Poppe for the photo of *Leptopoma perlucidum* f. *subalatum* and to B. Dharma for the photo of *Leptopoma niansense* Fulton, 1907. Thanks are also due to the reviewers for useful comments.

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Thach, N.N. 2018. New Shells of South Asia, 3 New Genera and 132 New Species. 48HrBooks Co., USA, 173 pp. (including 87 color plates).

Website of Philippe & Guido Poppe (Conchology Inc.) <https://conchology.be/>



Figures 1-5: *Leptopoma melanostoma janetabbasae* n.ssp., Selawati Island, Indonesia - 1, 2: Holotype 15.2 mm, LKCNHM- 3: Paratype 3, 13.6 mm (uncleaned specimen attached with red soil), NNT- 4: Paratype 1, 14.1 mm, BOR/MOL (red and blue colors are due to adjustment in make spiral ribs more visible) - 5: Operculum (top) & *Leptopoma melanostoma* (Petit, 1841), photo RMNH for comparison (bottom) - 6: *Leptopoma niasense* Fulton 1907, 13-15 mm, photo of Dharma, 2005 for comparison - 7: *Leptopoma perlucidum* forma *subulatum* Quadras & Möllendorff 1893, 14.1 mm, photo G. & P. Poppe for comparison - 8: *Leptopoma helicoides* (Grateloup, 1840) 12.0 mm, photo of Abbott 1989 for comparison - 10: *Leptopoma vitreum* (Lesson, 1830) 12.0 mm, photo of Abbott, 1989 for comparison - 11: *Leptopoma stainforthi* (Sowerby, 1842) 8.0 mm, photo of Abbott, 1989 for comparison - 9, 12: *Amphidromus inversus inversus* (Müller, 1774) 52.8 mm, Vietnam.



Have a shell collection you would like to donate to The San Diego Shell Club?

The San Diego Shell Club is interested in your shell collection. As a 501c(3) organization, all donations to our Club may provide a tax write-off. When we receive a donation we provide a letter describing the items that may be used when filing your taxes.

While we cannot provide a value, donations of up to \$5,000 do not require a written appraisal. Since tax laws change regularly we recommend that you check with your tax accountant before relying on any information provided here.

We are interested in all types of shells, marine or land and all genera and species, including books on shells as well as items related to shells such as artwork, storage cases and tools. Your donated items will be used to generate income to support the Club's efforts in continuing Public education about shells and conservation of marine life throughout the world. If you would like to donate, please contact David Waller, SDSC Acquisition Chairperson, at dwaller@dbwipmg.com to schedule a time to discuss charitable gifting.

CLUB NEWS

August 2018 events:

- **The 3rd Annual West Coast Shell Show** - see article on p. 276
- **Conchologists of America 2018 Convention in San Diego** - see article on p. 272

2018 September Party

Our annual end-of-summer September party was held on September 15, 2018, at Sylvana Vollero's home in San Diego. There was food, beverages, and lots of shells to share, trade and sell. A good time was had by all.

2018 October General Meeting

Our October general meeting held on October 27, 2018, at David & Felicia Berschauer's home in Laguna Hills. The speaker was Dr. Kimo Morris who gave a fascinating presentation on the results of his eel grass surveys in southern California, including the discovery of a sizable population of adult *Busycotypus canaliculatus* (Linnaeus, 1758) breeding in the eel grass beds in Huntington Harbor, Orange County, California. There was food, beverages, and lots of shells to share, trade and sell. The Club presented Dr. Morris with a custom shell mug and a copy of the Sea Shells of Southern California as speaker gifts.



Dear Members,

It was a pleasure serving as your President for 2018. This was an exciting and eventful year for our Club. The April auction was an overwhelming success with proceeds over \$4,000. The Club's display at the San Diego County Fair was magnificent and highly regarded by fair goers. The third annual West Coast Shell Show was one of the most well attended shows yet. At any given time during the day there were as many as thirty people viewing the exhibits and shopping for shells. In addition, a few dealers attending the COA, showed up early to participate in our show. Finally, the COA convention was a great success with over 170 attending. Even though the attendance was lower than those conventions held in Florida, it was the second highest grossing convention in COA history, bringing in an estimated combined proceeds from the oral and silent auctions of \$45,000-47,000. This was definitely one for the history books.

When we start this year, I informed you that I would focus my efforts in three key areas: membership, resources and attendance. In my February President's message I noted that our membership was about 60 and declining in 2015. With the hard work of our past two Presidents, Larry Buck and David Berschauer, we increased our membership to over 190; a record high membership for our Club. Unfortunately, my efforts to increase membership through local, national and international outreach were not as successful as hoped. My desire to increase membership to over 250 fell short and our membership for 2018 decreased slightly to 170 by mid year.

My hope to restore our Club's financial reserves to 2.5 times our annual budget is yet to be determined, but is anticipated to be a great success. Over the past three years, the Board of Directors has been planning for the COA convention; producing collectibles that the Board felt would generate income for the San Diego Shell Club at the convention. This included producing annual custom designed mugs and pins as well as publishing three books: *Jewels of the Everglades* by E. Petuch, D. Berschauer and R. Myers; *Seashells of Southern California* by D. Berschauer and R. Clark; and, *Treasures of the Sea* by M. Kaufman and P. Kanner. All of these items were blockbusters at our COA convention Club table and their sales increased our Club's reserves by 30%. With the proceeds from the November auction, it is estimated that the San Diego Shell Club will exceed expectations and increase our Club's financial reserves to the highest on record.

The third area that I had hoped to focus my efforts was overshadowed by the work required in preparing for the West Coast Shell Show and the COA Convention. Consequently, attendance at general meetings has remained the same. As I noted in my last President's message, I am not the first,

nor will I be the last, President with a desire to increase attendance at meetings. It has been an issue addressed by past Presidents and will continue to be a “work-in-progress” for the future. To the Club’s credit we have rotated our meeting locations to accommodate members living in San Diego as well as in Orange and Los Angeles Counties, we have increased the number of shells and other Club items for sale at our meetings and we have often provided food and drinks as well as stimulating presentations to generate interest in attending meetings. This will require some creative thinking and our new President and Board of Directors will likely address this issue.

In that regard, I would like to present my proposed slate of Officers for 2019: Lisa Lindahl, President; David Berschauer, Vice President; Nancy Hale, Treasurer; Lisa Lindahl and David Berschauer, will split the duties of Recording Secretary (unless and until a volunteer can be found); and Jill Spofford, Corresponding Secretary. Lisa Lindahl comes to us with years of experience in serving on our past Board of Directors, as Banquet Chairperson for the COA as well as assisting in a variety of capacities at the COA convention, contributing significantly to the Club’s exhibits at the San Diego County Fair, creating the logo for the 2018 COA Convention and providing “hands-on” support for our annual auctions just to name a few. David Berschauer has been one of the key driving forces for our Club; Co-Editor of the Festivus, Co-Chairman for the 2018 COA convention, host for numerous Club events including the Holiday Party and the November shell auction to name a few, author and co-author of many articles published in the Festivus, as well as author of two recently published books: *The Jewels of the Everglades*, and *Seashells of Southern California*. Nancy Hale has been a member for a few years and was the 2018 COA Registration Chairperson as well as participating in many of our Club events and general meetings. Jill Spofford is a recent member, and has jumped in with both feet, spending a significant amount of time helping with the 2018 COA convention. I am honored to be able to present this slate of Officers for your consideration and hope you will plan on attending the November auction to cast your vote. Once again, thank you for allowing me to serve as your President.

David B. Waller

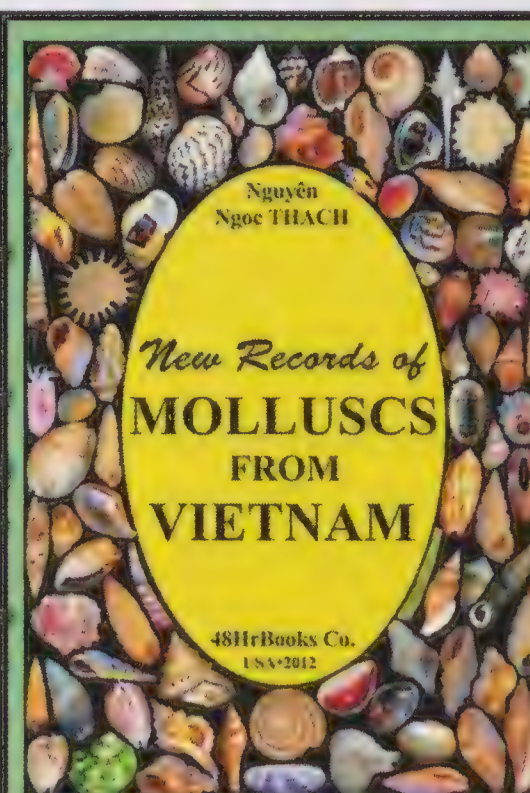


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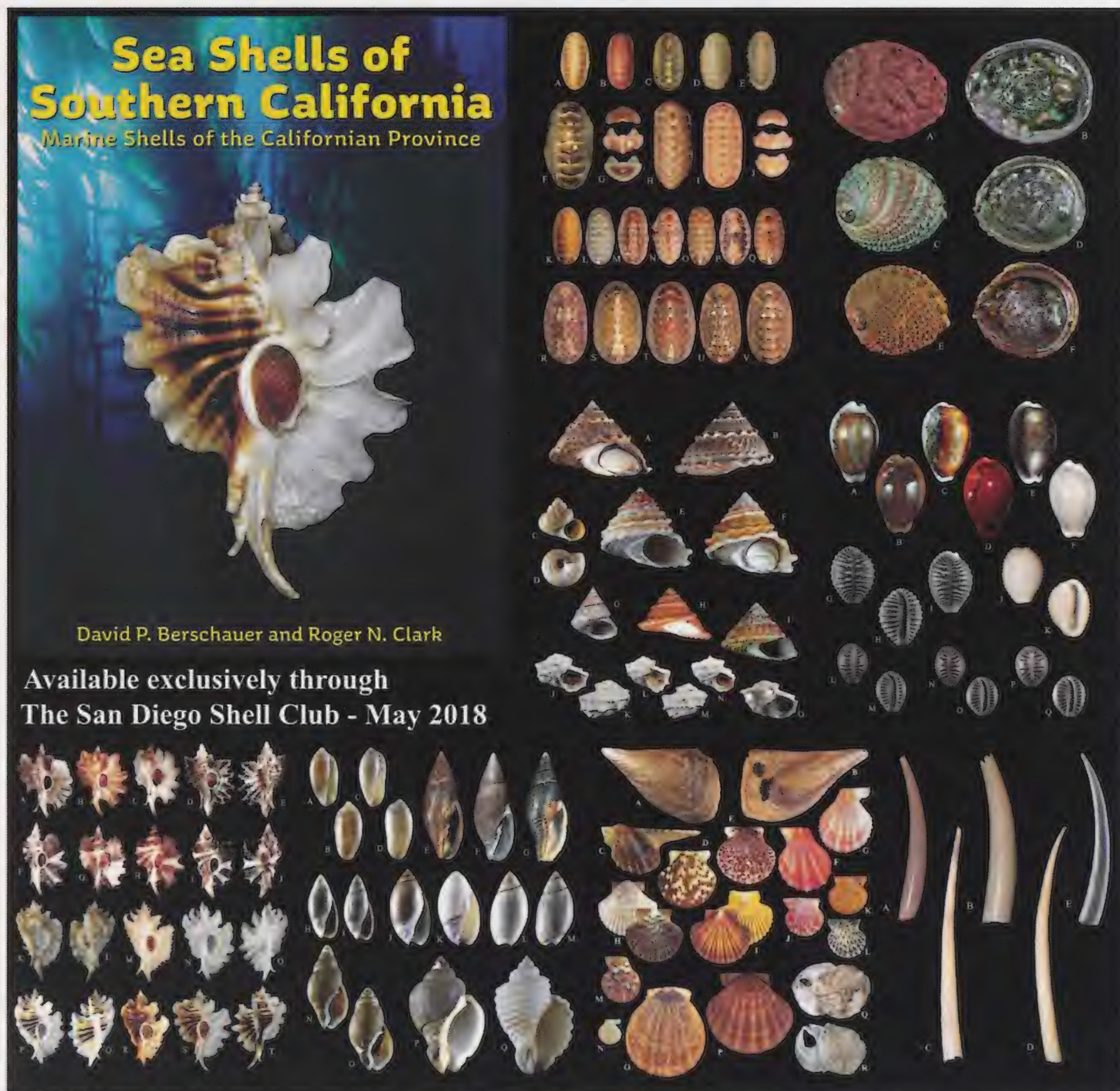
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COA 2018 Convention in San Diego

David B. Waller

505 Willowspiring Drive, Encinitas, California 92024

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As many of you know, back in 2015, the San Diego Shell Club's Board of Directors considered and approved hosting the 2018 Conchologists of America Convention. This was the third time that the convention was held in San Diego, with the first being in 1989 and the second in 1995. This COA convention was well received by all of its 170 attendees. The events began with two days of field trips organized by Dr. Paul Tuskes to Balboa Park, Scripps Aquarium and a dinner cruise on San Diego Bay. The convention opened on Wednesday with five presentations, and three silent auctions throughout the day, and ending with the Welcome Party Dinner organized by Jeanne Pisor. Thursday provided attendees six presentations, two silent auctions, ending with the highly anticipated Oral auction with auctioneer Hank Chaney working the crowd that evening. Friday provided one silent auction in the morning, another six presentations throughout the day, and ended with a Banquet organized by Lisa Lindahl and an underwater photography and video presentation by world renowned underwater photographer Bob Yin. Following the convention were two days of the long anticipated dealers' bourse, with 29 dealers offering shells for sale from around the world on Saturday and Sunday. Here are some highlights of the San Diego 2018 COA Convention:

Second highest income received for a COA Convention: Approximately \$45,000-\$47,000 (combined proceeds from the oral and silent auctions);

Presentation with the highest attendance: Ray Walker's presentation "ROV shell collecting": It is estimated that about 80% of convention attendees were present (Figure 1);

Highest price paid for a shell at the oral auction: \$6,000, *Austrotrophon catalinensis* (Figure 2);

Rare shell at the Bourse: *Phyllonotus eversoni*, a well-known Muricid offered by Donald Dan (Figure 3);

Rare fossil shell at the Bourse: *Marcromargarya aliena*, a large fresh water snail (Figure 4);

Rare shell identified at the Convention: golden or albanistic form of *Venusta episema sorrentensis* (very rare, Figure 5). Russel Renka brought a Zoila from an old collection identified as *Venusta thackeri*. The shell was examined and identified by Drew Strickland and Ray Walker;

Most talked about shell at the convention: *Forreria cortezianna*. The August issue of The Festivus published an article naming this new species recently found by dredging in the Sea of Cortez (Figure 6). Only a few of these specimens have been found and only a couple individuals were lucky enough to purchase these shells at the convention;

Coollest Fancy Hat at the Welcome Party: Anne Joffe's Jelly fish hat (really creative, it also has lights but they were not turned on during the contest); and

Special note: Banquet dinner centerpieces: Bailer shells, *Melo amphora*, were beautifully integrated with other shells, artistically decorated and lighted from the inside with electronic candles (Figure 7). Created by Lisa Lindahl and given away at each table to the lucky individual with a star taped under their chair; and

Amazing artwork: The COA convention logo, a beautiful open ocean image showing *Macrocystis pyrifera* (Giant Kelp) in the background, with *Haliotis rufescens* (Red Abalone) center, *Enteroctopus dofleini* (Giant Pacific Octopus) perched behind and looking over the abalone and *Austrotrophon catalinensis* in the foreground (Figure 8). All endemic species of Southern California and created by Lisa Lindahl. The original was sold at the oral auction to Don Pisor.

For more images and information about the 2018 COA Convention see the article by Harry Lee titled "Annual COA Convention: 2018 San Diego, CA; week of August 26" in the Jacksonville Shell Club's newsletter "Shell·O·Gram" September-October, 2018 Vol 59 (no.5).



Figure 1. Ray Walker



Figure 2. *Austrotrophon catalinensis*



Figure 3. *Phyllonotus eversoni*



Figure 4. *Marcromargarya aliena*



Figure 5. *Venusta episema sorrentensis*



Figure 6. *Forraria corteziana*



Figure 8. Logo of 2018 COA oil on wood



Figure 7. Banquet room with *Melo* centerpieces



New publication: *Treasures of the Sea, The Unique Seashells of California*, by Murray Kaufman and Paul Kanner. This landmark publication depicts the signature shells of California through outstanding photographs of exceptional specimens from important collections and fantastic *in situ* images of many of the living shells. Included in the text are descriptions of behaviors, habitats and geographic range never before published. An important resource for all shell collectors, this creative and artistic work will also be appreciated by anyone who loves the marine world. Sponsored by the San Diego Shell Club, the book is available August, 2018 and it can be purchased via their website for \$35 plus 8% sales tax and shipping at actual costs (\$5.00 in the USA). PayPal to SDShellClub@gmail.com

The 3rd Annual West Coast Shell Show

David P. Berschauer

25461 Barents Street, Laguna Hills, California 92653

shellcollection@hotmail.com

This was our Club's third annual shells show, and was intentionally planned to take place immediately before the 2018 COA convention in San Diego. When we chose the dates we had hoped to get international dealers and out-of-state shellers to attend our shell show, and our wishes were fulfilled. Not only did we have visitors to the West Coast Shell Show from the east coast of the country, and out-of-state exhibitors, but we had dealers from India (Moses Annai Raj) and Russia (Val Darkin). There were over twenty exhibits and over a dozen dealers with gorgeous shells from all around the world. The venue for the event, Casa del Prado in San Diego, never fails to produce large crowds of people who flock to see our shell show in droves. This year was our largest turnout to date, with well over 500 people coming in to see the exhibits and bourse the dealer tables on both Saturday and Sunday. The only real problem we had was that the room was not big enough for the event!



Figures 1-4. 1 = Crowds at the show. 2 = Mrs. Hames at their dealer table. 3 = Val Darkin. 4 = Moses Raj and his assistant Matthew.



Figures 5-10. 5 = Lisa Dawn Lindahl, COA Award and 1st Place Artistic Division winner; 6 = David B. Waller, Wes Farmer Educational Award Winner; 7 = David P. Berschauer, Shell of the Show winner - both self-collected and "any manner", and various ribbons; 8 = Artistic Award and original painting; 9 = Roger N. Clark, various ribbons; Scott Zaragoza, Festivus Award and various ribbons.

One of the best things about our shell show every year is the number of families with small children who come and fall in love with these beautiful jewels of the sea. Once again we had a table with shells for children to touch and take home with them for free - courtesy of the San Diego Shell Club and some of our sponsoring shell dealers. Many of our shell Club members and out-of-town guests came and enjoyed the shell show, shared stories, and purchased shells, shell books, magazines, mugs and pins. One of the Club's recent publications (Sea Shells of Southern California) made its formal debut to the enjoyment of visitors to the show, with many copies being purchased.

With so many great exhibits the judges had a hard time deciding on winners, however they eventually had to make some tough choices. The top award winners were:

- Conchologists of America Award - Worldwide Muricidae (Lindahl)
- Festivus Award (most aesthetically pleasing) - *Septifer bilocularis* exhibit (Zaragosa)
- Wes Farmer Educational Award - Unusual Characteristics of the Family Cypreidae (Waller)
- Shell of the Show (collected any manner) - *Forreria corteziana* (Berschauer)
- Shell of the Show (self collected) - *Austrotrophon catalinensis* (Berschauer)
- 1st Place Artistic Division - Original octopus and shells painting (Lindahl)
- 2nd Place Artistic Division - Silver King Tarpon made with pen shells (Barr)
- Exhibitors' Choice - Sea Shells of the Southern Californian Province (Berschauer)
- 1st Place One Region - Muricidae of Alaska (Clark)
- 1st Place One Family (Major) Worldwide Muricidae (Lindahl)
- 1st Place One Family (Minor) - Bradybaenidae of the Philippines (Zaragosa)
- 1st Place One Region & Family - Bradybaenidae of the Philippines (Zaragosa)
- 1st Place One Genus - *Morum* of the World (Berschauer)
- 1st Place One Species - *Nucella lamellosa* (Clark)
- Judges' Special Merit - Opisthobranch sculptures (Wes Farmer)



Figures 11-14. 11 = Lisa Dawn Lindahl and Phyllis Gray; 12 = Leo Kempczenski showing shells to a young family with kids; 13 = Charles Barr's Silver King Tarpon made with pen shells; 14 = David P. Berschauer and Amy Dick.

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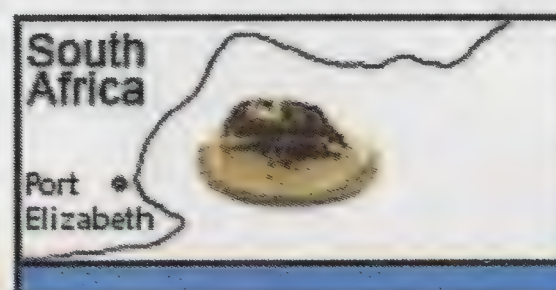
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E. adansonianus adansonianus (Crosse & Fischer, 1861), Bahamas, 106.1 mm. *B. poppei* (Anseeuw, 2003), Tonga Islands, 58.8 mm. *P. amabilis f. maureri* Harasewych & Askew, 1993, USA, 42 mm. *B. tangaroana* (Bouchet & Métivier, 1982), New Zealand, 55.9 mm. *P. quoyanus* (Fischer & Bernardi, 1856), Curaçao, 50.7 mm. *B. philpoppei* Poppe, Anseeuw & Goto, 2006, Philippines, 65.1 mm. *B. charlestonensis* Askew, 1987, Martinique, 77.3 mm. *B. midas* (Bayer, 1965), Bahamas, 82.7 mm.

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Back cover: *Siphovasum latiriforme* (Rehder & Abbott, 1951) from 53 to 58 mm in length, taken by shrimp trawlers at 800 feet on coarse carbonate sand among reef rubble in the Gulf of Campeche, Mexico. Photos taken by and used with permission of Andres Poremski. (Cover artistic credit: Rex Stilwill).

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